

Clearing the Path to Care

The University of Cincinnati and its affiliated medical centers stand on the cutting edge of medicine, offering expert guidance to those on the challenging journey of improving their health and wellbeing. But patients often run across barriers when attempting to access these resources. Whether it's an elderly hypertensive's inability to get a ride to the hospital, an HIV sufferer's fear of the disease or a speech-disabled child's distance from a therapist, these obstacles can keep people from making the most of vital treatments. The researchers profiled here hail from a wide range of academic fields, but all are driven by the desire to make high-quality healthcare highly accessible.

For Dr. Andrew Steckl of the UC College of Engineering and Applied Science, the road to innovation runs in parallel with an oft-travelled route to the hospital. His father had developed high blood pressure late in life, and his doctors had decided to treat him with anticoagulant medication. "That was maybe, in the scheme of things, not the worst thing that can happen to a person," Dr. Steckl recounts, "but nonetheless it was an issue because he had to be tested on a regular basis." Dr. Steckl was responsible for taking his father to the almost weekly monitoring sessions for his anticoagulants, battling the traffic between his home and the hospital for a test that took ten minutes at most to complete. Understandably, this hassle for both his father and himself led Dr. Steckl to ask whether there was a way patients could keep tabs on their anticoagulants, as he says, "without having to go to all that trouble."

The Steckls' annoyance reflects a much larger issue: although healthcare spending and availability have never been higher, many patients still face barriers to treatment. Whether due to logistics, lack of knowledge or cost, people often aren't able to access the resources they need to properly manage their health. Researchers from across the colleges of UC, including Dr. Steckl, are conducting research to address this difficulty, helping to bridge the gaps between caregivers and those in need.

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Dr. Steckl's training is in electrical engineering, and his lab's primary focus is the development of cutting-edge nanoelectronics. But the solution to his father's problem employs a much older technology: paper. Using the microfluidics principle of capillary action, the same phenomenon that causes paper towels to absorb spilled liquids, the resulting device draws a drop of blood from a sample pad at one end to a wicking pad on the other through a nitrocellulose membrane. The distance that the blood moves in a given time is determined by its viscosity, which is in turn influenced by its coagulation ability. Patients could self-test at home with this device to determine if their coagulation fell outside an appropriate range; if so, they would know to visit a doctor for more accurate quantitative testing and medication adjustment.

As an old radio plays classical music in Dr. Steckl's neatly arrayed office on the eighth floor of Rhodes Hall, he discusses the surprising synergy between electrical engineering and his foray into microfluidics. The complicated physics underlying how liquids behave may be outside his background, but working with circuits and semiconductors since

his graduate school days has made him an expert in crafting very small and intricate objects. "Because of this knowledge of microfabrication, we're a lot more comfortable with microfluidic devices; not the fundamentals, but the devices and the applications," he explains.

The engineer could channel this ability in a practical way thanks to his existing collaboration with Dr. Giovanni Pauletti of the James L. Winkle College of Pharmacy. Dr. Steckl had previously worked with Dr. Pauletti on several smaller projects, such as an array of paper needles designed to deliver medication with less pain and cost than a traditional syringe. That particular experiment wasn't successful, but he wisecracks that "the chemistry was good" with the pharmacy professor. Dr. Pauletti agrees that "personality-wise we get along well, and we can have hours of discussions" about what pharmaceutical problems can be addressed with engineering. The current project arose out of one of those far-ranging conversations after the two realized the significant impact it could have on the convenience of healthcare.

The task of transforming that concept into reality largely fell on Hua Li, who earned her master's of science with her effort on the project and continues to work on the device as a research assistant in Dr. Steckl's lab. Although the principles and materials at work were comparatively simple, Li still had to solve plenty of engineering challenges, from determining the right dimensions and materials for the device to dealing with inconsistencies in different batches of paper from the same manufacturer. Perhaps most difficult was calibrating the apparatus to handle the wide variation of blood properties found between

people. Luckily, she had some help from her fellow students for establishing a range of healthy responses. "It's half mandatory," she laughs. "Every lab member has been my volunteer."

Human testing is far from over, however, and pharmacy professor Dr. Michael Hegener is in charge of establishing the clinical usability of the device. In conjunction with his duties at UC, he helps run the anticoagulation clinic of a local hospital, which allows him to easily recruit anticoagulated volunteers for testing. Dr. Hegener says his patients are very excited about contributing to the research. "Some of them ask really in-depth questions about, 'Well, why do they think this is going to work?' And they want me to explain to them the science behind it." Like Dr. Steckl's father, most of these patients are elderly and reliant on others for transportation to the clinic, and giving them the ability to monitor their medication on their own would boost their independence and safety.

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-Joe Perazzo

The burden of continuous monitoring is the major hurdle for anticoagulation patients, but for those with other conditions, simply getting into care can be a bigger obstacle. Joe Perazzo, a recent doctoral graduate from the College of Nursing, finds this to be true for people with human immunodeficiency virus (HIV), the infection that leads to acquired immunodeficiency syndrome (AIDS).

Perazzo reflects on coming across the issue as he searched for a doctoral research project. "When I was going out into the literature, I was fascinated by people who would go get tested, get their test results and then—disappear." If HIV is diagnosed soon after transmission and treated promptly with antiretroviral drugs, the amount of viral particles in the blood can drop below detectable levels, greatly reducing symptoms and transmission risks. Timely entry into care is thus critical for newly infected HIV patients, but many people aren't following up on their test results. Perazzo's generally gregarious features go serious when he discusses the gap between the possibilities and realities of controlling HIV. "We have the resources in the U.S. for a person to have an undetectable HIV status, but less than half of the people in the country who have HIV are achieving that goal."

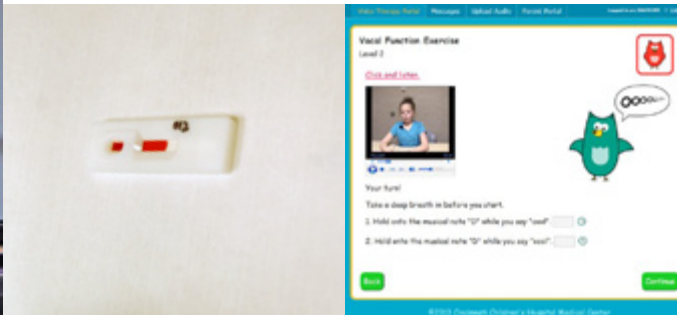
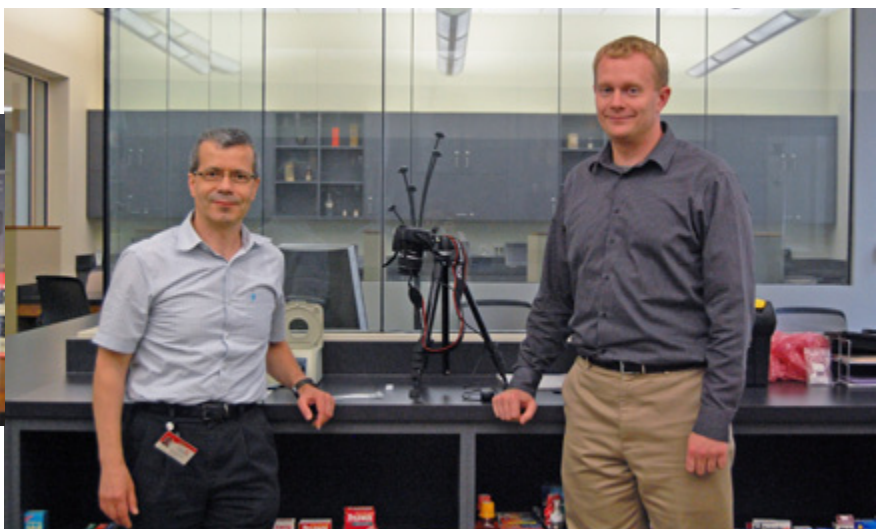
His literature review found little research examining how HIV-positive people come to initiate care after receiving their diagnosis, so Perazzo set out to interview recently diagnosed HIV patients who had made the choice themselves. Under the guidance of Dr. Donna Martsolf, Perazzo and several collaborators analyzed his interviews separately, then came together to discuss their perspectives on the patients'

stories. Half-jokingly, he notes that this approach was "the best way to see that it wasn't just the Joe Perazzo show"; the team had to achieve consensus before moving forward, giving methodological rigor to the study's conclusions.

Together, the interviews suggested that patients process an HIV diagnosis in the manner of "bad news." Nearly all study participants described how, after they had received and interpreted this news, they came to the realization that HIV was not necessarily "a death sentence," despite their existing preconceptions. After patients incorporated the news based on their better understanding of the disease, they took the action to initiate HIV care—and began to move beyond the news. "It's not like everybody goes through it the same way," Perazzo explains, "but those were consistently the major stopping places." Individual responses to the news are most profoundly shaped by perceived susceptibility to HIV, the presence of symptoms, feedback from others and HIV information.

Importantly, many new patients shared that they drew their assumptions about HIV from messages in the mass media, which often don't reflect the current state of treatment. Early public faces of HIV/AIDS, such as Rock Hudson and Tom Hanks's character in "Philadelphia," were often portrayed as ravaged by the disease and unable to control its progression. "These are ingrained images in their minds," Perazzo emphasizes, "regardless of what is actually going on in the current climate of healthcare." Those visions of unstoppable degradation by HIV can lead to hopelessness or resignation, discouraging people from seeking care.





"Many participants believed their outlook was bleak," Perazzo continues, "until they met the new intake coordinator." This first point of contact with the HIV care system was crucial for correcting the inaccurate media-based messages and other misinformation patients had believed about the disease. Just as important was the emotional support offered to people still reeling from the doubts and fears of their diagnosis. Perazzo says that the coordinator "completely puts all of that to rest and lets them know that, short of something else happening to you, you're going to live your life." h

Perazzo will further explore his model of diagnosis as news during a postdoctoral fellowship at Case Western Reserve University, where his entire focus will be on HIV intervention research. By expanding on the lessons of his research, he hopes to target different interventions to people in unique diagnosis situations. "There were several people [in my study] who thought they were going into the hospital for a flu or pneumonia that wouldn't go away," he offers as an example. "They learn in that environment that they have HIV! How can we develop interventions for people like that?" Much like the very first interactions with a new intake coordinator set the groundwork for a patient's success, Perazzo's initial research is laying foundations for the future improvement of HIV care.

The importance of the new intake coordinator to HIV patients speaks volumes to the importance of a personal touch in healthcare. Some doctors wonder, however, if that personality need be delivered in person. Dr. Lisa Kelchner, a clinical research speech

pathologist at the Cincinnati Children's Hospital Medical Center and an associate professor for the College of Allied Health Sciences, has been testing that assumption through a telehealth system for administering pediatric voice therapy.

Dr. Kelchner's colleagues at CCHMC are regarded as international leaders in pediatric airway reconstruction surgery, drawing patients from as far away as Australia and the Middle East. But after their operations, these children often need extensive therapy to adapt to their new vocal anatomy, and therapeutic specialists such as Dr. Kelchner may not practice anywhere near the recovering kids. "After we do our piece," she says, "they don't have anybody in their area who specializes in this kind of treatment." Even people who live closer to speech clinics may be overwhelmed by the logistics of getting their children into treatment: Dr. Kelchner notes that many families "have to drag three children to sit in a waiting room in those after-school hours between 3:30 and 7, when they have to crowd in piano lessons and soccer practice and deal with crosstown traffic."

In 2012, Dr. Kelchner won a nearly \$300,000 federal exploratory grant to pilot a program for addressing these issues by delivering personalized voice therapy over the Internet. Together with two graduate

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in regards to her research on telehealth for speech pathology

students, Casey Keck and Katherine Davidson, she recruited ten families from CCHMC's weekly voice disorder clinic to test different methods of remote speech therapy. The team both treated children in real time and developed an interactive web portal loaded with therapeutic exercises so kids could practice independently between sessions. With a clinician's patient humor, Dr. Kelchner jokes that the tracking capabilities afforded by this website gave her useful (if sometimes disappointing) data: "A lot of the little kids said, 'Yes, we did our homework,' and we could see they hadn't even gotten on!"

Although Dr. Kelchner outfitted every participant with the necessary software and hardware for the study, including high-quality headsets and microphones, her team still encountered some glitches in delivering treatment. Children's voices are particularly tricky to capture with high acoustic fidelity because of their higher pitch, so the therapists sometimes had trouble identifying particular problems from their recorded speech. Additionally, the Internet connections of the families sometimes fell below the study's desired bandwidth; the team had to tinker with the software so it would accept slower connection speeds. Despite these technical troubles, Dr. Kelchner says the greater convenience and lack of transportation costs associated with telehealth means "families are begging for this"; many wanted to continue receiving remote therapy even after the study's end in 2014.

Dr. Kelchner notes that while the public is enthusiastic about the possibilities, mainstream healthcare "still has some suspicion" regarding the use of telehealth

treatment. She admits that some of this resistance is appropriate caution; at this early stage, practitioners must still solve technical problems and validate clinical procedures. But she gently chides those concerned with losing the intimacy of a face-to-face meeting by pointing out an already widespread medical practice: "With electronic medical record keeping, most of what you see in your physician's office when you visit is their back as they enter stuff into the computer."

Regulatory paperwork also poses a hurdle to the widespread adoption of telehealth. According to current laws, therapists must be licensed in each state where their patients receive care, so those working remotely could need a ream of credentials. "Even if we're sitting in Cincinnati, and we diagnosed them and saw them and evaluated them in Cincinnati, if they go back to Pennsylvania, we have to have licensure in Pennsylvania," she explains.

But Dr. Kelchner remains hopeful about the potential of remote care for her field and for medicine in general. She and her graduate students are now working on a federal grant to evaluate the efficacy of their treatment program, as well as address the technical issues they identified in the pilot study and survey families about the benefits they experience as a result of telehealth. Creating a strong research foundation for new treatments, Dr. Kelchner says, is absolutely crucial. Work on the cutting edge is exciting, but "the challenge is to do it right. And that's what inspires me, is to help do it right."