SOUNDLY INVESTED

STUDENTS' INNOVATION COULD IMPROVE CARE FOR PATIENTS WITH LUNG DISORDERS, EVEN FROM AFAR

BY WHITLEY HILL

For many U-M medical students, the thrill of having successfully completed their first year doesn't translate into any kind of permission to — dare it be uttered —relax. Instead, they take a breath, regroup, then ride their new and bristling knowledge right into a summer filled with research, courtesy of the Medical School's Summer Biomedical Research Programs.

If their project is chosen — proposed research can be basic science, clinical, or a combination — students receive a stipend and then dive into 10 weeks of funded, mentored research. For nearly all of them, it's the first step into the world of academic research in medical science. Many students gravitate toward analyzing data, or suggesting new models for clinical care.

But Clay Bavinger had a different idea. He'd spent two "gap years" at Stanford, where he'd earned his undergraduate degree, crunching numbers and interpreting health policy data — valuable work, but ephemeral. This time, he wanted to build something he could hold in his hands. But what?

He decided to take a medical procedure that is practiced millions of times a day, all over the globe, and put a new, practical spin on it.

Take a deep breath. Another. Now breathe normally ...

"The motivation for my project was to capture quality lung sounds in a way that's never really been done before," says Bavinger. "Lung sounds aren't typically recorded, so it's difficult to hear how they change over time. But also, what if there were microphones all over the chest? That's a bit of a new idea; lung sounds are typically heard in one location at a time."

But Bavinger didn't stop there. Could the microphones be worn? Like a vest? And if so, why couldn't they be worn in a patient's home — say during a mild asthma attack or a bout of bronchitis — and have the recorded sounds be transmitted to a specialist 100 miles away, or anywhere in the world?

As the saying goes — and anyone with an iPhone knows — we have the technology. With the right tweaking, Bavinger thought he might be able to come up with a device that could revolutionize one of the most common procedures in medicine.

Even at that early stage, Bavinger knew he lacked the technology and computer skills to make his concept a reality. Over dinner one night at Phi Rho Sigma, a medical fraternity near the Medical School, he pitched the idea to his friend and fellow first-year student Fred Howard, who has a degree in computer technology.

Howard signed on. They'd do their summer research program together and with any luck emerge with a working prototype: a wearable device that could accurately transmit and record sounds from different areas of the chest.

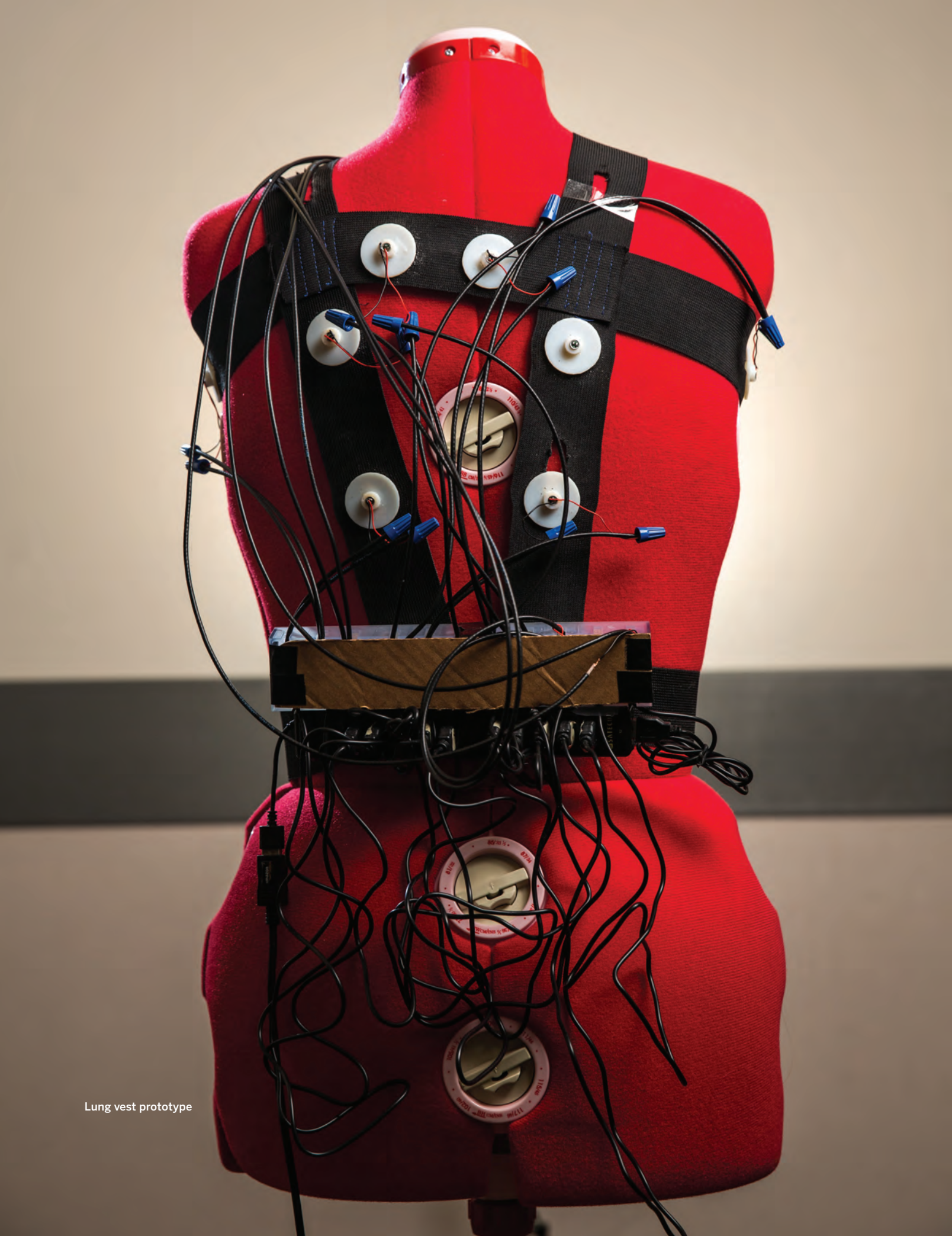
Excited, Bavinger began looking for a faculty advisor. He reached out to David Burke, M.D., a professor of genetics who also heads a new U-M program called Distributed Health Technologies.

"In a nutshell," explains Burke, "Distributed Health Technologies is looking for low-cost, easy-to-manufacture technologies that can be easily distributed to help people manage their health care."

In his initial meetings with Bavinger, and later Howard, Burke helped them develop the idea. "We worked on it together until it became a project that

Matt Christensen, Clay Bavinger and Fred Howard with the vest prototype

PREVIOUS PAGE: CLINT BLOWERS; THIS PAGE AND OPPOSITE: AUSTIN THOMASON, MICHIGAN PHOTOGRAPHY



Lung vest prototype

was doable. You can think about a lot of projects but can you do them?"

As the summer of 2012 approached, Bavinger and Howard began to think they could. But before they started, they learned of another opportunity: the U-M's Global Health and Disparities Path of Excellence Program.

Also aimed at medical students in their first and second years, the Global Health and Disparities Path has a more specific mission: to address the dramatic health and health care inequities in the United States and across the globe. It's designed to be a first step for those medical students who are considering a career in this area. Bavinger was intrigued.

"I worked on a few projects during my job after college that concerned global health outcomes, so I had real interest in global health and disparities," he says. "When the application deadline came around in February of 2012, I decided there was just no way I could skip out on this program."

In fact, the chest sounds device project seemed tailor-made for a global health focus. A bonus was that the learning environment of the Paths of Excellence Program would allow the project to continue on into Bavinger and Howard's second year.

When classes ended in the spring of 2012, the pair began work on the device as their summer biomedical research project.

Howard points out that electronic stethoscopes already exist, but they cost upwards of $300 and record only one place on the body.

"The unique part of our project is the concurrency — the fact that multiple lung sounds are recorded at once," says Howard. "We had to find a way to record good quality lung sounds with a microphone in the cheapest way possible."

Howard decided on unidirectional "electret" microphones, each a bit smaller than a penny, then Bavinger figured out how to use a basic sewing machine and stitched the microphones into a tight-fitting, elastic "vest." After many weeks of trial and error — listening to their own lungs and roping their friends in when possible — they began to get good results: clear, recordable sounds from multiple areas of the chest.

"The sounds right now are recorded onto a computer," says Howard. "The interface has a layout to the patient's chest and you can click on areas you want to hear and highlight certain sounds."

Brent Williams

AUSTIN THOMASON, MICHIGAN PHOTOGRAPHY

Tom Sisson (M.D. 1992, Residency 1995, Fellowship 1998), a U-M pulmonologist, served as Bavinger and Howard's clinical advisor. The three of them sat down to think creatively about how such a device could be used, in the clinic and beyond.

The trio realized that the vest could offer improved access and quality of care for patients with chronic medical conditions, such as asthma, that disproportionately impact low-income populations. Patients far from a medical center could record chest sounds at home, then transmit the audio files to a specialist who could interpret the data and start on a proper course of action. The device could also provide an additional resource for students who are learning to recognize the sounds of chronic disease.

"We initially thought about asthmatics," recalls Sisson. "Asthma can vary from day to day and hour to hour, depending on what triggers a patient has been exposed to. And patients are notoriously bad judges of how severe the obstruction in their lungs is. Some are hyperperceivers; others are very poor perceivers of how severe their disease is. This might be a way for patients to monitor themselves, and to provide access

to patients who don't already have access. If a patient could record multiple areas of the lungs by putting on a vest and taking a few breaths, that could be a powerful tool."

Last fall, Sisson invited Bavinger and Howard into his clinic and tried the device on two patients who volunteered to help. The vest worked exactly as they'd hoped.

Still, Sisson cautions that the project is in its infancy and there are many details to be worked out and questions to be answered. For example, accuracy in interpreting breath sounds depends, in part, on how deeply the patient is breathing. How would that be standardized?

Nonetheless, he says, he is happy to help students who are experiencing research for the first time. "As the project evolves, they'll see where the pitfalls are and learn from them. They'll redirect and make new hypotheses. This could potentially be quite useful. I'm excited to see how it turns out."

"LUNG SOUNDS AREN'T TYPICALLY RECORDED, SO IT'S DIFFICULT TO HEAR HOW THEY CHANGE OVER TIME. BUT ALSO, WHAT IF THERE WERE MICROPHONES ALL OVER THE CHEST? LUNG SOUNDS ARE TYPICALLY HEARD IN ONE LOCATION AT A TIME."

Enter Verizon Wireless.

In early 2012, the media juggernaut approached the Health System Development Office inquiring about programs and projects at Michigan that were addressing disparities in health care through the development of innovative technologies. The company was particularly interested in health care disparities here in the United States. Development staff told Verizon about U-M's Global Health and Disparities Path of Excellence.

Brent Williams, M.D., an associate professor of internal medicine and director of the Path of Excellence, worked with UMHS Development, along with Bavinger and Howard, to apply for the Verizon funding, citing the lung sounds project as a perfect example of the intersecting themes the company hoped to support. In the fall of 2012, the project got the nod from Verizon, to the tune of $50,000.

"This was my first grant for a project that was 'mine.' I was thrilled!" says Bavinger. "Lack of money would have been a serious obstacle. Support from Verizon gives us the resources we need to do this project the right way, not cutting corners, and hopefully make something of real value to patients."

"I was more of a midwife to this deal than the actual parent," says Williams, adding that he's excited to see medical students involved in groundbreaking research so early in their education. The Verizon support recognizes that many incoming students are deeply aware of global health issues; many, too, enter medical school with extraordinary technological skills — and a determination to hit the ground running when it comes to research.

Of the experience with Verizon, Williams says, "It really opened my eyes to the value of brokering relationships between some of these great student projects and outside organizations and donors. The growth of telemedicine is exciting stuff and a place we need to be growing. I fully expect Clay and Fred's project will move forward and spawn other technology support as we get our feet wet."

As for Bavinger and Howard, they've wrapped up their second year of medical school and, using the Verizon funding, are manufacturing 100 lung sound devices. A professional seamstress is crafting the vests, while a U-M engineering lab is handling the electronics.

Aware that once the notoriously challening third year starts up in the fall, they won't have a lot of spare time, the duo recently brought on board some fresh students to help keep the project going. The new students, including Matt Christensen, will be working directly with 100 patients — fitting them with the vests, teaching them how to use them, then gathering and interpreting lung sounds — as their 2013 summer project.

From a distance, their mentors watch with pride and satisfaction as the next generation takes confident steps forward.

"Teaching someone to be a scientist is more about guiding than directing," says Burke. "Now, Clay and Fred know way more about this project than I do. And I will be able to work with equally intelligent students next year and the year after that.

"The way I look at it," he says, "this is what makes teaching fun." [M]