

# Breakthrough acoustic device helps detect coronary artery disease



- **Business Needs** - Reliable way to transmit medical data from remote locations to AUM servers for analysis
- **Networking Solution** - Internet of Things global connectivity enables rapid, secure transmission of patient data to AUM and diagnostic test results back to clinicians
- **Business Value** - The ability to deliver potentially lifesaving information in minutes rather than days or weeks
- **Industry Focus** - Medical technology
- **Size** - Start-up

## About AUM Cardiovascular™

AUM Cardiovascular founder and CEO Marie Johnson Ph.D., created CADence™, a handheld device that looks for Coronary Artery Disease (CAD). The device, which is about the size of a computer mouse, records a patient's heart sounds and uses sophisticated acoustic detection and analysis to help healthcare professionals determine the state of a patient's cardiovascular health within minutes. The company's name, AUM, is a Sanskrit syllable which means "to make a continuous low humming sound." AUM extracts information akin to a humming sound from diseased coronary arteries.

## Situation

CADence has the potential to bring advanced medical diagnostics to populations with little or no access to cardiologists and other medical specialists. Its advanced technology enables health professionals to record heart sounds and send the data to AUM, where its servers use proprietary algorithms to conduct an acoustic analysis. While CADence initially used Wi-Fi to transmit the data, it found that many healthcare facilities had spotty, unreliable Wi-Fi signals. For CADence to fulfill its lifesaving potential, especially in rural areas and developing countries, AUM needed robust and dependable connectivity.

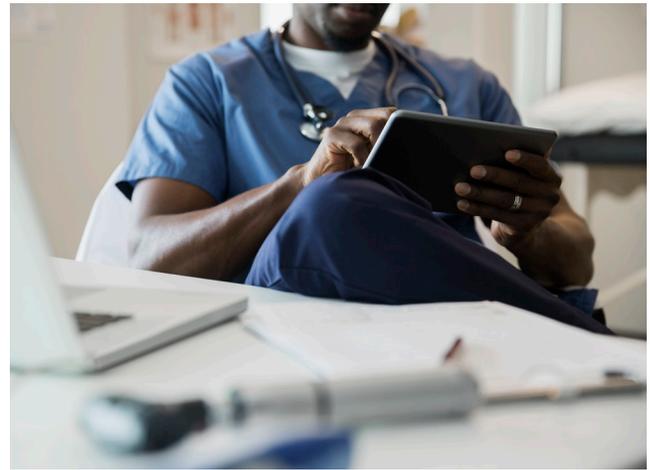
## Solution

AUM now uses Internet of Things (IoT) global connectivity provided by AT&T to facilitate its cardiac testing. CADence collects heart sound data and records it on a tablet computer. The AT&T Global SIM card in the tablet sends the information securely to AUM servers for analysis. Within about 10 minutes of the data upload, the clinician receives the results via email.

## Mining Heart Sounds for Vital Information

Marie Johnson created AUM Cardiovascular after losing her seemingly healthy 41-year-old husband to a sudden heart attack. A former mechanical engineer in the automotive industry, she entered grad school in biomedical engineering and was working to develop digital stethoscope technology at the time of her husband's death. As part of her research, Dr. Johnson had collected cardiac data from her husband for months. She had detected a faint, unusual sound in his heart, but a stress test ordered by his physician revealed no cardiac problems.

Coronary artery disease (CAD) is difficult to diagnose without invasive, expensive testing, Dr. Johnson said. "Treadmill stress tests miss 33 percent of people with significant blockages. Other tests are better, but are not indicated in young, healthy people," she said. "Coronary artery disease is a fixable condition. If they can detect it, they can fix it. We needed something better."



After losing her husband, Johnson channeled her grief into her studies, determined to find a way to identify the heart sounds that could indicate a narrowing of heart valves and potential coronary artery disease. After 14 years of work, her digital stethoscope had evolved into CADence, a revolutionary device that looks for coronary artery disease risk factors in patients in the sound of blood flow in their coronary arteries. The handheld device collects sound data on four locations of the patient's chest. Within about 10 minutes of the data upload to AUM servers in Minnesota, the clinician receives the results via email. The entire process takes about 20 minutes.

"CADence is a low-cost solution that can be performed almost anywhere," Dr. Johnson said. The device could replace procedures that traditionally cost more than \$10,000 and require million-dollar equipment, and specially trained doctors. In addition, before CADence, patients often had to wait weeks to get results. "We provide immediate information – not just for the wealthy and insured. We provide access for everyone," she said. The solution has the potential to have a dramatic impact; the Centers for

Disease Control and Prevention report that heart disease is the leading cause of death for both men and women in the U.S., claiming more than 600,000 lives each year. More than half of these deaths are due to coronary heart disease, which is undiagnosed in many people. Dr. Johnson hopes that CADence will make it easier and more affordable to diagnose heart disease, “taking the attack out of heart problems.”

AUM software uses proprietary algorithms to analyze the acoustic data it receives from CADence and generate a report for the patient’s physician to help determine the state of the patient’s cardiovascular health. AUM also plans a release of algorithms that crunch the same data to determine if arteries are clogged with plaque, a condition known as stenosis. For primary care doctors, stenosis is particularly hard



to detect because patients don’t exhibit noticeable symptoms. Normal screenings are not good predictors of stenosis. Technologies like computer topography, MRIs and ultrasounds can spot stenosis by measuring everything from thickness of artery walls to calcium deposits, but these can be expensive. “A primary care doctor is unlikely to refer patients to pricey specialty clinics, especially if the patient doesn’t

show any outward signs of the disease,” Dr. Johnson said. “CADence offers clinicians a low cost, effective way of helping to spot heart disease before it’s too late.”

## The Right Connections

In 2015, as AUM officials waited for FDA approval in the U.S., they launched CADence in Germany, and learned an important lesson about connectivity. “We used a standard computer, and we were going to harness the clinic’s Wi-Fi connection,” she said. “And it was a complete disaster. The connectivity was intermittent and just not reliable.” The cinderblock walls used in many medical facilities can interfere with Wi-Fi, and installing signal extenders is expensive since an extender would be required in every room. AUM needed universal, dependable connectivity to support its groundbreaking innovation. The need for connectivity would become more intense in 2017, when AUM received FDA clearance to introduce CADence in the U.S.

After reading about CADence, an AT&T Internet of Things (IoT) business manager arranged to meet with AUM officials at the Consumer Electronics Show in Las Vegas. Dr. Johnson and her team considered the breadth of available solutions, and chose to use Internet of Things (IoT) global connectivity provided by AT&T to transmit patient data and deliver AUM’s diagnostic test results. Now CADence sends patient data to a tablet with an app custom built to work with the AT&T wireless services. The AT&T Global SIM card in the tablet sends the data in a highly secure manner to AUM’s secure server in Minnesota. Minutes later, the clinician receives an email with the results.

A true pioneer, AUM Cardiovascular is the first-ever medical device company to put a cellular service plan in place to support its device. “AT&T worked with us to create the equivalent of a shared family plan for all of our clinics all over the world who use our device,” Dr. Johnson said. “Clinicians are now working from cellphones and tablets that create data portals for our CADence data.”

AUM benefited not only from its connection to the AT&T 4G LTE network, but from the connections AT&T helped it make with software engineers who could help develop and integrate AUM’s apps. AUM had initially hired overseas developers, but soon experienced problems. “I came out of Stanford and was in Silicon Valley for a while, where the talk on the street is that you can hire Indian or Russian firms to write your apps and do the integration, and it’s smooth and cheap,” she said. “We tried to do that, and it was another disaster. Our experience was that it’s really difficult to get it to work properly.”

With AT&T, she said, “There was no option not to do it right. The integration was very smooth.” Additionally, the developers that AT&T recommended were successful in helping AUM launch its groundbreaking technology. “AUM is a tiny little company in Northdale, Minnesota,” she said. “AT&T has massive teams of engineers and app developers and partners that do it for AT&T because it has such a big reach and so much influence in this industry.” Beyond AT&T’s technical expertise and the breadth of its relationships with other companies, Dr. Johnson said, is the know-how and commitment of the AT&T professionals who worked with AUM. “It really is the people, when you think about it,” she said.



“We do have access to other cellphone carriers, but AT&T had the team that really made the difference. Working with them has been amazing.”

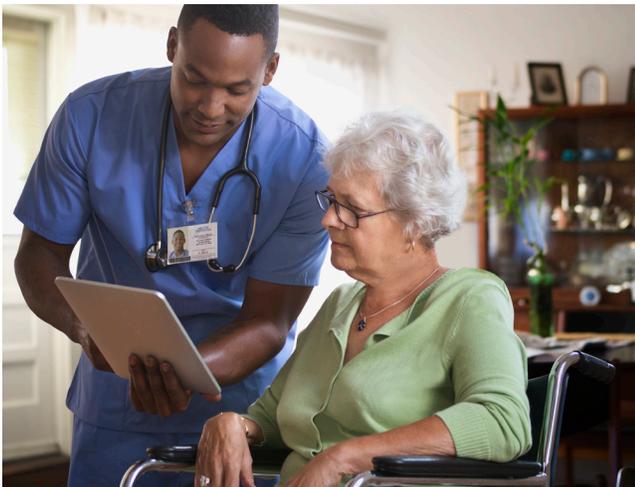
## Disrupting the Status Quo, Saving Lives

In mid-2017, after AUM conducted years of intensive testing and collected data on more than a thousand patients, the FDA approved CADence for use in the U.S. “We got the approval and we were ready to get it to the American public and start saving lives,” she said. The company has placed 1,000 systems so far, and has what Dr. Johnson calls a “massive outpouring of interest” throughout the world. AUM is keeping the price of CADence low, she said, “because we’re trying to make this available to everyone.”

AT&T connectivity means that CADence can be used in remote locations where patients who don’t have access to heart care specialists can benefit from its breakthrough technology. “Our goal is to get it into rural areas, taking advantage of that AT&T cellphone connection,” she said. “Currently we’re launching in

some outlying areas in Australia. Thanks to the AT&T cellular collection, people there will be able to use CADence.”

AUM has applied for FDA approval to train individuals to use CADence in their homes. “Our goal is for patients to collect the information, file it and send it to the doctor,” she said. Being able to use CADence at home could potentially reduce trips to the Emergency Department or cardiologist, and make life easier for post-surgical patients.



It could also improve healthcare in areas with few, if any, cardiologists. For example, she said, there are only 666 cardiologists practicing in all of Mississippi, while New York City about twice as many. “CADence is a low-cost solution that can be performed by minimally trained individuals anywhere near an AT&T tower,” she said. “We’re proud of that.”

The company continues to find ways that CADence can save lives, extending its advanced cardiac testing

to the animal population. Since many veterinarians provide care far away from their clinics, AT&T connectivity will be important. “Obviously, you can’t tap into a Wi-Fi connection if you’re out in a barn,” she said, “but as long as they have cellphone coverage, we can get the data and do the testing.” In addition, an automotive company that’s installing biometrics technology into carts plans to build CADence devices into car seats, Dr. Johnson said. “The idea is that the consumer would get into their car, in the morning and they’d get a CADence test, which includes an ECG,” she said. The data would be sent to a read center for analysis, and if there were a problem the consumer would get a message to see a doctor or, in emergencies, to call an ambulance.

AUM is like many healthcare providers and insurance companies that are utilizing data to try to optimize pharmaceutical interventions and provide better care for patients with conditions like hypertension, Dr. Johnson said. “We use Artificial Intelligence to perform our analytics, and any time we collect patient data, we can use Artificial Intelligence to improve it,” she said. “And so, over time, as more and more patients are tested, we’re going to be able to disrupt a billion-dollar industry – not just nuclear stress testing, but every stress testing modality.”

After losing her husband, Dr. Johnson said she understands firsthand the devastation coronary artery disease can cause. “We are using the latest technology and AT&T global connectivity to quickly and easily determine if CAD risk factors are present,” she said. “We hope to prevent tragedy for other families.”

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