



TELEMEDICINE, AI, AND DEEP LEARNING ARE REVOLUTIONIZING HEALTHCARE

By Veronica Combs

HOW TELEMEDICINE KEEPS PATIENTS IN RURAL COMMUNITIES HEALTHY



IMAGE: CHILDREN'S MERCY KANSAS CITY

Technology is often blamed for taking away jobs. In the healthcare industry, radiologists—the people who read MRIs and CT scans—are worried about being replaced by algorithms. However, one type of technology may actually save healthcare jobs, particularly in rural areas: telemedicine.

Consulting with a patient via video has the potential to hit [healthcare's triple aim](#): better patient experience, better health overall, and lower costs. It also may keep rural hospitals in business.

“Telemedicine is great for families because no one wants a sick loved one 250 miles away,” said Mike Phillips, MD, MBA, of [Intermountain Healthcare](#). “It’s good for hospitals because it helps them stay fiscally sound, and it’s good for local providers, who can work with experts on complicated cases.”

Phillips is the managing director at [Intermountain Ventures](#). He was the chief of clinical and outreach services at Intermountain Healthcare previously. Intermountain is a Utah-based not-for-profit system of 23 hospitals, 170 clinics, and about 2,300 physicians.

Connect Care Pro is Intermountain’s technology platform and medical care that extends specialist care to rural hospitals. The service includes 35 telehealth programs and about 500 caregivers, and it provides basic medical care, stroke evaluation, mental health counseling, and intensive and newborn critical care.

Providers use the service at Intermountain’s 10 rural hospitals, as well as nine hospitals outside of the system. The telemedicine providers have their own command center at Intermountain’s main campus in Salt Lake City, with dozens of monitors and multiple data streams coming in for each patient. New members of the team work through numerous simulations before working with patients or other doctors remotely.

The platform is a combination of services built in-house and purchased from vendors. “We use [Skype for Business](#) for hospital to hospital communications and [American Well](#) for our direct to consumer consultations,” Phillips said. “80% of the goodness is the solid video connection and the ability to have that right at the bedside. The other 20% is the health record and other information.”



A DOCTOR IS DOING A STROKE EVALUATION VIA VIDEO. (IMAGE: INTERMOUNTAIN)

SUCCESSFUL TELEMEDICINE REQUIRES HIGHLY SKILLED DOCTORS

Phillips said that finding the right doctor to work in the telemedicine group is as important as having the right technology. “This work takes a master clinician, and we are very careful about who we select,” he said.

Morgan Waller, the director of telemedicine business and operations at [Children’s Mercy Kansas City](#), said that finding the right doctors and nurses is crucial. If a healthcare provider doesn’t see the value in the telemedicine, this can doom an entire project.

“The real problem may be that a provider doesn’t want to provide care this way, but technology will get blamed for the failure,” she said. One way to get around this is to take advantage of the competitive nature of physicians. “If you can get the early adopters, the rest will follow because they want to keep up with everyone else,” she said.

The telemedicine doctors at Intermountain use a tactic called [appreciative inquiry](#). This communications method helps build a good working relationship between the two providers that is collaborative instead of hierarchical. “We don’t tell someone they’re doing something wrong, we give them a reading of the situation and ask what they think we should do next,” he said. Phillips said this technique is critical to developing trust with the person on the other side of the screen.

“This is a huge cultural shift, but that’s OK because it’s a huge benefit to our patients,” Phillips said. “The technology is a vehicle to flex expertise from one geography to another. We want to get our expertise in an appropriate way to any bedside within reach of a cell tower.”

TELE-ICU PROGRAM OFFERS INTENSIVE CARE FOR ADULTS AND NEWBORNS

Intermountain’s oldest remote care service is the tele-ICU program. This collaboration between doctors in Salt Lake City that work with doctors in rural areas has reduced death rates in intensive care units and helped patients go home sooner.

“We have enabled local providers to take care of sicker people and to do a better job,” Phillips said.

Telemedicine services also help mothers and new babies. The team specializes in [neonatal resuscitation](#). About 10% of all babies born each year need help to start breathing. These babies need special care that many doctors can’t provide. When a rural hospital staff anticipates that a baby will be born early, the Salt Lake City team and the local doctors assemble for a practice run for the delivery.

“This allows everyone to sharpen their skills right before the delivery is going to happen,” Phillips said. The medical transport group is also part of this team just in case the baby needs to come to the main hospital. “We can flip to a transport immediately if we need to because they’ve been watching the case in real time,” he said.

VIRTUAL CARE VITAL TO FINANCIAL HEALTH OF RURAL HOSPITALS

Keeping people in their local hospitals can be the difference between financial success and bankruptcy. Since 2010, [93 rural hospitals](#) have closed, including 17 in Texas, nine in Tennessee, and seven in Georgia. This means people who need to see a doctor have to drive hours to do so. In 2014, 54% of rural communities [did not have a hospital with a maternity ward](#). That means about 2.4 million women of childbearing age live in counties without hospitals that deliver babies.

Small and rural hospitals have been under [intense financial pressure for decades](#). Many rural hospitals see fewer patients, and those patients [are older, poorer, and sicker](#) than patients at urban hospitals. Rural residents are more likely to get insurance from Medicare and Medicaid also; those programs pay less for healthcare services than insurance from employers. This combination of factors can mean long-term financial difficulties or even going out of business.

The political whiplash around healthcare has also threatened the financial health of rural hospitals. Hospitals in states that expanded Medicaid as part of the Affordable Care Act [are in better financial shape](#) because more people have health insurance. In addition, small hospitals are supported by [Medicare “extenders,”](#) extra payments designed to help them survive. These extenders cover everything from low patient volume to rural ambulance services.

Phillips said the most important goal for telemedicine is to keep patients at their local hospital. Some babies born prematurely are healthy enough to breathe on their own but need to gain weight before they can leave the hospital. “The worst thing you can do is separate mom and baby,” he said. “With the appropriate monitoring and right people on the ground, we can keep mom and baby together.”

EXTENDING SPECIALIST CARE TO RURAL AREAS

Children’s Mercy Kansas City uses telemedicine to keep kids and families at home instead of driving anywhere from four to eight hours to get to a specialist. Instead of emergency care, Mercy doctors and nurses use technology for routine checkups and specialty care.

“Kids who have a chronic health condition have to go to the doctor up to six times per year, and you can only get specialist care at certain hospitals,” Waller said. “These doctors wouldn’t be able to pay off their med school loans if they lived in rural America.”

Mercy serves rural and urban patients in Kansas and Missouri. The main hospital offers 47 specialties, and 30 of those providers offer [telemedicine services](#). The hospital has four regional outreach centers that offer specialty care.

Waller joined the telemedicine department in 2012 with a new chief medical informatics officer and one part-time physician. “Everything I wanted to do, I got ‘No,’ for an answer from risk management and billing and legal,” she said.

Until recently, there was no consistent approach from state to state for telemedicine. In May 2017, Texas was the last state to allow a doctor to see a patient for the first time via screen, instead of requiring an in-person meeting first. Also in 2017, the [Interstate Medical Licensure Compact](#) went live; this makes it easier for physicians in member states to obtain licenses to practice in multiple states. Each of the 22 member states retains its right to regulate clinicians and take punitive action, as needed. Kansas participates in this agreement—Missouri does not.

In Kansas and Missouri, a doctor must be licensed in that state to practice medicine there. This common rule has slowed the adoption of telemedicine because getting licensed in multiple states can be difficult and expensive. Legislatures in both states have started to modernize these rules, but progress has been slow.

VIRTUAL HEALTHCARE IS JUST AS EFFECTIVE

In 2018, Children’s Mercy had 2,341 patient visits across all specialties via telemedicine. This was up from 1,644 telemedicine appointments in 2017.

Mercy’s four satellite clinics use [InTouch](#), a modular telehealth platform that can integrate with existing health IT systems or stand alone. The InTouch software ensures a reliable video connection by giving video traffic priority. “It’s a great system that manages bandwidth to make sure you get priority on network traffic,” Waller said. “InTouch is like an ambulance.”



IMAGE: CHILDREN’S MERCY KANSAS CITY

During a telemedicine visit, a nurse or respiratory therapist manages the technology. The “tele-facilitator” starts the video connection with the doctor at the main Mercy campus. The facilitator uses the video connection, as well as instruments such as a digital stethoscope, an otoscope, and a high-resolution camera, to conduct the exam. These devices allow the doctor in Kansas City, MO, to see exactly what the nurse in Junction City, KS, is seeing.

The telemedicine platform also allows interpreters to be present for a visit. “Our interpreters can be in the room with the provider or sign in virtually and join in a third video stream,” Waller said.

A [recent study that involved Mercy patients](#) with asthma found that virtual visits are just as effective as in-person visits at helping kids get control of asthma symptoms.

Mercy also tracks patient satisfaction with telemedicine visits compared to in-person visits. A recent survey showed that 65% of parents and kids were equally satisfied and 33% were more satisfied with telemedicine care. Additionally, 82% of parents said their child could see a specialist sooner via telemedicine, which improves both access and quality of care.

Waller said that initially it was a challenge to find nurses to run the remote clinics; over time, the technology element of the job has become a recruitment tool. “These jobs are considered an expanded nursing role and because they see patients with several different illnesses, these nurses become multi-specialty facilitators,” Waller said.

The daily variety in the work also keeps nurses engaged. “We are able to attract the best of the best because the work is never boring,” she said. “We offer tons of autonomy also, and highly skilled nurses really appreciate that.”

WHAT’S THE NEXT FRONTIER?

As [government officials](#) and health insurance companies [slowly solve the payment problem](#) for telemedicine, hospital systems can expand their offerings.

Phillips at Intermountain said one of his top priorities is a mental health integration program. “We will be delivering behavioral health in the primary care doctor’s office with the help of telemedicine,” he said. “We want to help primary care doctors globally care for the health of the patient in part because people with depression will end up having more physical diseases as well.”

Intermountain also will add rheumatology and dermatology to its list of telemedicine services.

At Mercy, Waller wants to go where the patients are. “I want very very much for us to be in schools so kids can see specialty providers in school,” she said. “And hopefully because they are a captive audience they won’t miss the appointment.”

AI PLATFORMS AIM TO EASE INFORMATION OVERLOAD IN HEALTHCARE

Many digital health companies build dashboards for doctors to share data from a device or an app. The entrepreneurs often see this as an important product feature; in reality, most doctors have no time or interest in yet another source of patient data.

Doctors and nurses are already drowning in information. The problem is not a lack of information but knowing how to best use it. Doctors and nurses need technology platforms that make it easier to analyze health data and make treatment decisions.

This is the real role for artificial intelligence in healthcare: helping doctors and nurses make decisions. As two Babson College professors write on NEJM Catalyst, AI in healthcare is about [augmentation not automation](#).

Two startups—[Arterys](#) and [Astarte Medical](#)—are taking this approach to AI, specifically [machine learning](#). Each company is focusing on a different slice of the information overload problem and aiming to “reduce the cognitive workload” for doctors and improve care for patients.

HOW ARTERYS IS ANALYZING MEDICAL IMAGES FOR PATTERNS

Healthcare systems have extensive libraries of X-rays, CT scans, MRIs, ultrasounds, and PET scans; researchers are using these scans to train algorithms to spot skin spots that may be melanoma or nodules in lungs that could be cancer. This analysis of thousands of scans can spot patterns that humans miss.

The idea is to have the algorithm do the first pass on the multiple images generated from one scan. The next step is to look for patterns identified in the larger analysis in an individual’s records. The [deep learning](#) platform then makes a recommendation to the doctor about what to review more closely or what treatment to consider.

Arterys is building these “AI assistants” to inform treatment decisions and automate certain tasks. The company has six products for heart scans, one product for analyzing liver lesions, and one product for lung nodules.

What does Arterys do?

[Arterys’ 4D Flow](#) software reads an MRI of the heart and provides an analysis of [how blood flows through the four chambers of the heart](#). The software also calculates other heart health data points that an MD usually calculates after drawing by hand the contours of the four chambers as shown in the MRI. Unsurprisingly, the software is much

quicker at this math. Arterys has similar products for lung and liver scans; the focus with those products is to track change over time as a measure of disease progression.

How does Arterys help?

Engineers don't use slide rules for complex equations any more, and cardiologists now have a replacement for their manual tools, though the software does not factor in a patient's medical history, co-morbidities, or medication regimen. Doctors can now spend the 60 to 90 minutes previously dedicated to these calculations on other tasks, such as considering the complex interactions of other illnesses that might be affecting the heart or consulting a colleague on a particularly challenging case. By automating some of the work of analyzing scans, a doctor can spend more time with patients explaining a treatment plan or discussing the treatment options.

This technology also has the potential to [reduce variation in healthcare](#). While there are standards of care that doctors are expected to follow, anyone who has sought out a second opinion knows that two doctors can look at the same medical record and make two completely different treatment recommendations. Some variation is good and to be expected, but many healthcare leaders are hoping that deep learning technologies will reduce this variation, reduce costs, and improve patient outcomes as a result.

Who is Arterys's target customer?

Hospitals are the most likely purchasers. Adoption by radiologists will determine the success of this approach to treatment. The fear is that hospital executives will want to replace humans with these deep learning platforms; the reality is that these analytical platforms will [change the workflow and task lists for doctors](#), not replace them entirely.

HOW NICUTRITION IS PROTECTING PREEMIES' TUMMIES

Another company using AI as decision support in healthcare is focused on premature babies. Doctors know a lot about how to help preemies breathe but less about how to make sure the digestive system is functioning correctly. As it turns out, gut health directly influences [brain health](#) and a [baby's risk of learning disabilities](#) later in life.

Astarte Medical is developing a machine learning system to help doctors customize feeding and antibiotic treatment plans for each baby based on each individual's gut health. This technology has the potential to reduce unnecessary antibiotic use (which is a huge issue in public health) and to help tiny babies get the right nutrition at the right time.

The fear is that hospital executives will want to replace humans with these deep learning platforms; the reality is that these analytical platforms will change the workflow and task lists for doctors, not replace them entirely.

What does it do?

Astarte's [NICUtrition platform](#) takes existing data from the medical record and analyzes it to measure the health of the preterm infant's gut. The software extracts 200 data points from medical records to create a gut health score and the appropriate feeding recommendations. NICUtrition Guidance makes the feeding suggestions, and NICUtrition MAGI calculates the score.

Treatment recommendations could include an increase or decrease in antibiotics or in food.

How does it help?

Many babies born early are at risk of [necrotizing enterocolitis](#). This illness causes the gut biome to malfunction and eat away at the intestine, which in turn causes systemic infection. The disease occurs in nearly 10% of premature infants. The MAGI gut health score could help identify infants who are at the biggest risk for this problem.

Also, preemies often have developmental delays because a lot of brain development happens in the third trimester. In the last 13 weeks of pregnancy, the fetal brain triples in size. Brain development in a neonatal intensive care unit is very different from brain development in utero. The quality and quantity of a preemie's diet can have a direct effect on brain development.

Who is the target customer?

Target customers are children's hospitals and hospitals with neonatal intensive care units. Reducing the number of days in the NICU is good for everyone. Healthcare costs for premature babies can be up to \$6,000 per day. That doesn't even count the emotional and physical cost to family members and the babies themselves. Personalizing treatment could help babies grow faster and go home sooner, increasing the family's quality of life and reducing healthcare costs for everyone.

Also, as much of the gut biome research is new, doctors do not have the expertise yet to assess this health risk and take action. NICUtrition has the potential to bring this cutting-edge research into the hospital quickly.

HOW DEEP LEARNING HELPS MATCH THE RIGHT PATIENT WITH THE RIGHT HEALTHCARE

Most healthcare systems and insurance providers know who the high-risk patients are: usually people living with chronic conditions—diabetes, asthma, heart disease—who aren't managing their health well enough. These individuals are at a high risk of ending up in the ER. There are several problems with this high-risk list approach to caring for patients.

First, these risk scores are often compiled using insurance claims. This is a limited data source, and it is all about the past, not the present. This is not the kind of decision support that prevents readmissions or gets the right care to the right person at the right time.

Second, insurers and physician practices often use phone calls to check in with these individuals. This method is as inefficient as it sounds.



IMAGE: METAMORWORKS

Finally, this approach doesn't provide any clue as to what is preventing an individual from being healthy. The healthcare providers know who the sickest people are, but they don't always know what the person needs to stay healthy. The missing element could be [transportation to doctor visits](#), [medication reconciliation](#), financial support to buy food or prescriptions, or even more frequent doctor visits.

The promise of artificial intelligence in healthcare is to help doctors and nurses—and even insurance companies—match the right care at the right time to the right person. That change—mass personalization in healthcare—is the promise of the specialized version of AI called [deep learning](#).

Deep learning is branch of machine learning. Deep learning systems are modeled on the human brain. These artificial neural networks learn by passing data through layers of algorithms. Training data is fed into the bottom layer. Each node in the layer assigns a value to a data point. If the value passes a certain threshold, the data moves on to the next layer, [until it arrives at the output layer](#). During training, these thresholds are adjusted until analysis of similar data sets yield similar outputs.

MIT is using this technology to simulate a clinical trial to determine [the lowest possible dose of chemo for people with brain cancer](#). They are also working on a model that could [suggest treatments for sepsis](#).

Health tech companies are using deep learning to, for instance, predict which person will develop pressure sores during a hospital stay or which heart attack patient will be back in the hospital within a week. Doctors need deep learning tools to compile data from multiple sources, look for patterns, and rate risk at the patient—not the population—level.

Jvion and Cyft are two companies developing technology platforms to help doctors make treatment decisions informed by a much wider data set and ultimately help patients get the most appropriate care.

HOW JVION IS MAKING HOSPITALS HEALTHIER

[Jvion](#) describes its technology as a “cognitive clinical success machine” built with an [Eigen Spheres engine](#). The engine is an n-dimensional space upon which millions of patients are mapped against tens of thousands of Eigen Spheres. This is a mathematical way of talking about how complex health is and how many factors influence it. A doctor could do everything right in the hospital setting only to have other factors outside the hospital sabotage a person's health.

Health tech companies are using deep learning to, for instance, predict which person will develop pressure sores during a hospital stay or which heart attack patient will be back in the hospital within a week.

What does Jvion do?

Jvion uses its Eigen Sphere engine to combine many sources of data about a patient—including clinical, socio-economic, and behavioral—and to consider many possible outcomes. This analysis creates an individual risk score based on data from the individual patient, as opposed to a more general score based on broad demographics like age and medical condition. This analysis considers whether a person is moving toward or away from health problems.

For example, older people can develop new health problems after a hospital stay—issues unrelated to the original illness that sent them to the hospital in the first place. Jvion’s predictive technology could help identify people at the highest risk for this “post-hospital syndrome” and prevent the [associated downward spiral for older patients](#). Jvion also works with hospitals to prevent [healthcare-associated infections](#) in America, a problem that affects 5 to 10% of hospitalized patients in the US per year. These infections have [resulted in about 99,000 deaths and an estimated \\$20 billion in healthcare costs](#) in America.

How does Jvion help?

Healthcare systems now have a financial incentive to reduce hospitalizations due to [provisions in the Affordable Care Act](#), a law passed in 2010 in America that improved access to healthcare. Hospitals face a financial penalty if Medicare patients with certain conditions return to the hospital within 30 days. A study published in 2017 predicted that [these Medicare penalties](#) for American hospitals would be \$528 million in 2017, \$108 million more than in 2016. The benefit to patients is obvious: personalized care that fits an individual’s particular situation.

Who is Jvion’s target customer?

Target customers are hospitals that serve a lot of Medicare patients or that are working in [value-based contracts](#), instead of the traditional fee-for-service model. These contracts link payments with better outcomes for patients instead of the volume of care provided. Medicare is leading the way with the transition, but some healthcare systems are moving to this system as well. Healthcare leaders need new tools and decision-making processes to make this huge shift away from the traditional healthcare business model.

HOW CYFT USES DATA ANALYTICS TO PERSONALIZE PATIENT TREATMENT PLANS

While Jvion is working inside the hospital, [Cyft](#) is focused on the world outside the doctor’s office, which is where most of our healthcare challenges exist. Research on the American population suggests that direct medical care [represents only about 20% of the factors](#) that influence a person’s health. Socioeconomic factors such as education, income, and family support have the biggest impact at 40%; healthy behaviors are next at 30%; and the environment has the smallest impact at 10%.

This focus on home life, economic status, and a person's overall environment is a significant shift for healthcare leaders. Many [population health startups](#) have emerged over the last few years to help health systems address problems such as food insecurity, substance abuse, and homelessness. As more health systems move to pay-for-performance payment models instead of fee-for-service, healthcare leaders have to figure out how to address these “outside the doctor's office” influences.

Leonard D'Avolio, Ph.D., the co-founder and CEO of Cyft, thinks that healthcare systems have all the data they need to do this, but they just don't know how to use the information effectively. The other key is to analyze the most relevant data. Cyft's promise is to make sense—and predictions—from [small sets of messy data](#). Cyft's technology analyzes information from multiple sources to determine what kind of care a patient needs as well as the likelihood that a particular solution will work.

What does Cyft do?

Cyft (as in sifting through stacks of information) helps a healthcare provider figure out [which patients would most benefit from a particular intervention](#); this could be a phone call, an office visit, a change in medication, fall prevention, or mental health care. The Cyft software pulls in data from separate sources—patient surveys, health assessments, [EHRs](#), doctors' notes, call center transcripts—and identifies the most relevant risk factors. This assessment provides a priority list as well as personalized recommendations for patients. Two other examples of Cyft's work are identifying patients who are likely to have longer hospital stays after surgery and analyzing therapy notes for 300 American veterans with PTSD to [determine whether they were receiving “best practice” care](#).

How does Cyft help?

Many times, a care provider has to guess as to what a patient needs or which person needs immediate attention. Cyft's analysis can recommend treatment plans that fit the individual. Cyft can make predictions for all patients in a health system, including healthy people with no prior hospitalizations.

Who is Cyft's target customer?

Health systems that are “at-risk” or “[value-based](#).” When healthcare providers take on “risk,” their payment for services can be lowered if a patient picks up a hospital-acquired infection or if their condition worsens. The goal is to help a person become—and stay—healthy. Cyft also works with insurance companies to improve member retention and with government-sponsored health plans to improve reimbursement rates.

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