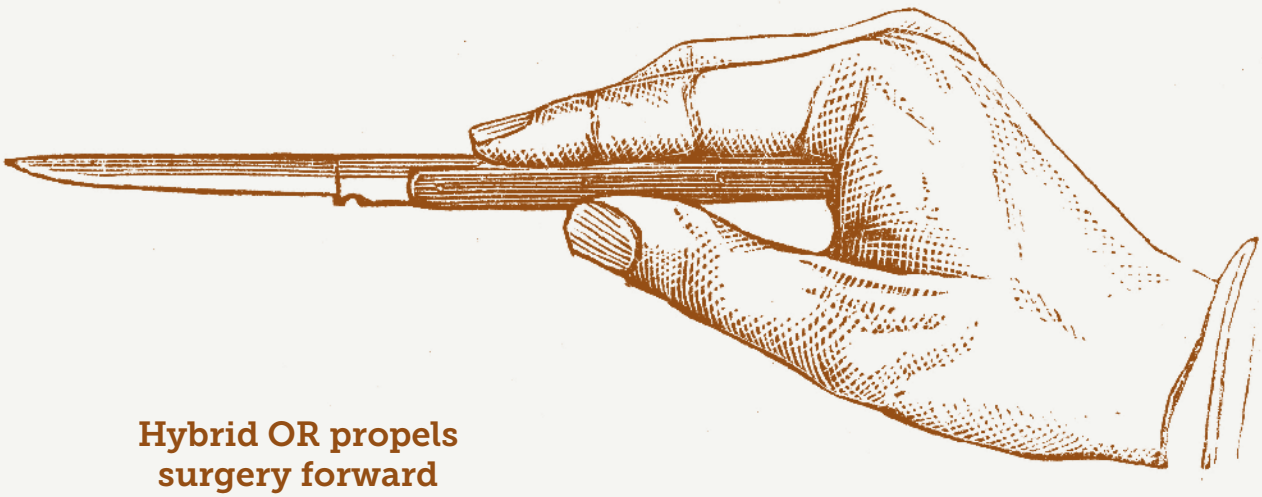
PROGRESSNOTES

MUSC'S MEDICAL MAGAZINE // FALL 2020



Hybrid OR propels surgery forward

New device improves safety for surgical staff

High-def surgical suite gives clear view

Telehealth pivots to fight COVID-19

Patient voice gives optimistic reminder

Statewide COVID-19 trials ensure inclusion for all

MUSC Ranked State's No. 1 Hospital Sixth Year in a Row

MUSC Health University Medical Center in Charleston was named the No. 1 hospital in South Carolina by U.S. News & World Report for the sixth year in a row, with three specialty areas ranking among the best in the country: ear, nose and throat; gynecology; and cancer. Six other MUSC Health programs based in Charleston are considered "high performing" in the 2020-2021 U.S. News & World Report rankings: gastroenterology and GI surgery, nephrology, neurology and neurosurgery, orthopaedics, rheumatology, and urology. In addition, MUSC Health Florence Medical Center is designated "high performing" in chronic obstructive pulmonary disease (COPD) and heart failure, and MUSC Health Lancaster Medical Center is designated "high performing" in COPD and heart failure.

"These six consecutive years of recognition demonstrate that our teams remain committed to keeping the needs of patients as the focal points of what we deliver every day," said **Patrick J. Cawley, M.D.**, MUSC Health CEO and Vice President for Health Affairs, University. "With all the pressures bearing on the health care industry right now, especially during this pandemic, yet again earning this level of recognition as the leading health care organization in the Charleston area, the Lowcountry and the state engenders a tremendous sense of accomplishment and pride in our teams' abilities to change what's possible for those we serve."

The Best Hospitals 2020-2021 report is designed to help patients with life-threatening or rare conditions identify hospitals that excel in treating the most difficult cases. The annual report includes consumer-friendly data and information on 4,500 medical centers nationwide in 16 specialties and 10 procedures and conditions.

"It is particularly gratifying to see two of the newest hospitals within the MUSC Health system, in our Florence and Lancaster divisions, recognized in this year's report," Cawley said. "Our teams statewide are engaged in delivering health care that is built on quality, safety and innovation at every level."

Have feedback on Progressnotes? We'd love to hear from you!

pnotes-magazine@musc.edu

@MUSChealthPN

MUSC Health
Medical Video Center
MUSChealth.org/medical-video

A sampling of current videos:

Advanced Digital Exoscope Provides Unparalleled Vantage Point for Pediatric Neurosurgery
Ramin Eskandari, M.D., performs a spinal cord detethering procedure with fluid pocket release on a 15-month-old child, and he explains how optimal surgical field visualization enhances patient safety and manages surgeon fatigue.

Using the Penile Scrotal Approach During Penile Prosthesis Surgery To Treat Erectile Dysfunction
Marc Rogers, M.D., illustrates penile prosthesis surgery as an option for men who have diminished erectile function and no longer find oral medications or other options effective.

Brexanolone Infusion Provides Fast Symptom Relief for Women with Postpartum Depression
Constance Guille, M.D., a reproductive psychiatrist and director of the MUSC Women's Reproductive Behavioral Health Program, details the first FDA-approved treatment for moderate to severe postpartum depression.

Precision Cranial Reconstruction Using Custom 3D-Printed Skull Prosthesis
Nathan Rowland, M.D., shares technical details and sample footage of a unique cranial reconstruction case where the frontal portion of the skull was removed and later replaced using a precisely mapped 3D-printed skull prosthesis.

Hyperthermic Intraperitoneal Chemotherapy for Abdominal Cancers
MUSC surgeon Ramsay Camp, M.D., discusses HIPEC for patients with cancer within the peritoneum, which is hard to treat with intravenous chemotherapy.

PROGRESSNOTES

MUSC'S MEDICAL MAGAZINE // FALL 2020

2

In Short

Surgical Safeguard

Heart Attack in a Dish

Killing Cancer with Protein Production

Targeted Tissue Salvage on the Mind

8

A New Kind of Hybrid

Partnership between innovative physicians and Siemens Healthineers brings a new operating room to MUSC Health

10

Putting Adverse Reactions Back on the Shelf

Health care teams at MUSC incorporate pharmacists to help with medication safety and adherence

12

Allies in the War Against COVID-19

MUSC Health Network joins forces to study COVID-19 across South Carolina

14

The High-Def Surgical Suite

Holistic 3D perspective transforms neurosurgery and kicks off collaborative partnership with Synaptive

18

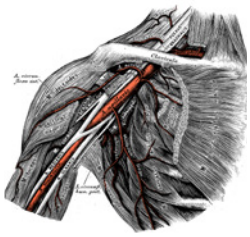
Through the 3D Glass

A spinal cord detethering case demonstrates how the clearest vantage point protects both surgeons and their patients

20

Pandemic Pivot

Telehealth rapidly scales up during the COVID-19 pandemic to provide care to patients in the safety of their homes



24

Patient Perspective

A sit-down between a shoulder replacement patient and his surgeon

26

Welcome

MUSC
Medical University of South Carolina

The Guardian needle, an innovative solution to the risk of needlestick injury during and after intraoperative monitoring.

INNOVATION

Surgical Safeguard

FDA approves Guardian needle to reduce risk of accidental needlesticks during intraoperative monitoring

BY CAREN DOUEIRY

Medical University of South Carolina neurophysiologist **Jessica Barley, Ph.D.**, and neurologist **Jonathan C. Edwards, M.D.**, noticed that needle electrodes used to monitor a patient's nervous system function during surgery can also pose a safety risk. Stranded uncapped needles can find their way into health care workers or even patients. Working with the **Zucker Institute for Applied Neurosciences (ZIAN)**, an MUSC technology accelerator, and Rhythmlink International LLC, a medical device manufacturer headquartered in Columbia, South Carolina, the team created a novel safety electrode that has the potential to reduce needlesticks.

The electrode, known as the Guardian needle, was recently approved by the U.S. Food and Drug Administration for intraoperative monitoring (IOM). The technology has been licensed to Rhythmlink, which is ramping up production for a rollout to hospitals nationwide this autumn.

"We thought it was unacceptable and unfair that the team providing the care to the patient should be put in harm's way by equipment that was meant to do the opposite and ensure patient safety," said Barley, who runs the intraoperative neurophysiology program at MUSC Health and is coinventor of the Guardian needle.

During high-risk surgical cases, the neurophysiology team uses IOM to monitor a patient's nervous system and record it in real time. The process involves inserting approximately 40 needles throughout the patient's body and connecting them with long wires to the IOM machine.

However, the setup increases the risk of needle dislocation. Currently available needles can become uncapped when dislodged from the patient's skin. This results in a danger of needles sticking the staff while in the operating room (OR).

"We don't have to accept that a certain number of our staff is going to get stuck by an IOM needle," said Edwards, chief of the Integrated Center of Clinical Excellence in Neuroscience at MUSC Health and coinventor of the Guardian needle. "It's our

responsibility as people in the field to solve this problem."

The Guardian needle should protect the surgical team from harm because it is never uncapped. It was designed to deploy the electrode only when inserted into the patient.

"It automatically retracts when it's not in the patient," said Paul Asper, vice president of commercialization at ZIAN.

The design also includes adhesive bandages around the needles. The adhesives enable the team to secure needles to the patient without manually taping them, thus decreasing OR time and cost.

"We did timed trials," said Barley. "Just trying the full setup the very first time using the new design, we were all faster," she said, comparing the new needles with the needles they had used before.

Not only does the Guardian needle protect the surgical team and decrease OR time, but it also enables better patient care by reducing the risk of needlesticks to patients. The adhesives on the needle also secure it in place despite shifts in patient positioning. The adhesives thus ensure signal integrity as the electrodes monitor nervous system function during surgery.

The clinician-innovators were able to come up with the clever design because they were personally familiar with the clinical problem they were trying to address.

"Clinicians have great ideas all the time," said Edwards. "But 99% of those ideas die, mostly because we don't have time."

Enter ZIAN, with the expertise, knowledge and resources to turn an idea into a product. In the case of the Guardian needle, the ZIAN team developed a business plan and patent strategy, raised funding for research and development, engineered the prototype and forged a licensing agreement with a world-class medical device company, saving valuable time for the busy clinicians.

"The expertise on the ZIAN team aligns perfectly with the clinical expertise of the inventors, enabling both parties to execute on their strengths," explained Mark Semler, CEO of ZIAN. The core mission of ZIAN is to develop and bring to market technologies that solve unmet clinical needs.

Rhythmlink, a South Carolina-based company specializing in medical devices that record or elicit neurophysiologic biopotentials, has licensed the technology and begun to ramp up its production. Their unique position in the industry allowed them to recognize the importance of this invention. That, combined with their contribution to the intellectual property, design enhancements for manufacturing and expertise in regulatory guidelines, helped the product become a reality.

"This is a great example of South Carolina organizations collaborating in the health care space," said Shawn Regan, cofounder and chief executive officer of Rhythmlink. "Creating a safer work environment for health care professionals absolutely aligns with our mission to improve patient care. Working with ZIAN and MUSC to develop the Guardian needle and bring this creation to life was a no-brainer from a collaboration standpoint."

Successful commercialization of the product and the widespread distribution that Rhythmlink can provide are key to realizing a potentially industry-changing standard of care. As the novel electrode is rolled out in hospitals across the country, researchers will collect needlestick data to determine whether it is safer than the current standard of care. If it is safer, it would likely become the new standard of care, given federal workplace safety rules.

To the inventors, the Guardian needle provided a way to make a difference not only for their MUSC Health colleagues but also for surgical team members across the globe.

"In health care, we gladly and eagerly place ourselves at risk every day when we're caring for others. But it does have an element of stress and anxiety," said Barley. "This invention is particularly special because we're not only caring for our patients in a safer way, but we're also protecting our teammates. It feels like a way of giving back to them."

Edwards explained that it is this type of innovation that has enabled him to help patients and health care providers he will never meet.

"We always think of clinical practice, teaching and research as the three pillars of medicine," he explained. "There's a fourth pillar, and that fourth pillar is innovation."

"This invention is particularly special because we're not only caring for our patients in a safer way, but we're also protecting our teammates. It feels like a way of giving back to them."
—Jessica Barley, Ph.D.

PHOTO: JOSHUA AARON PHOTOGRAPHY, PROVIDED BY RHYTHMLINK

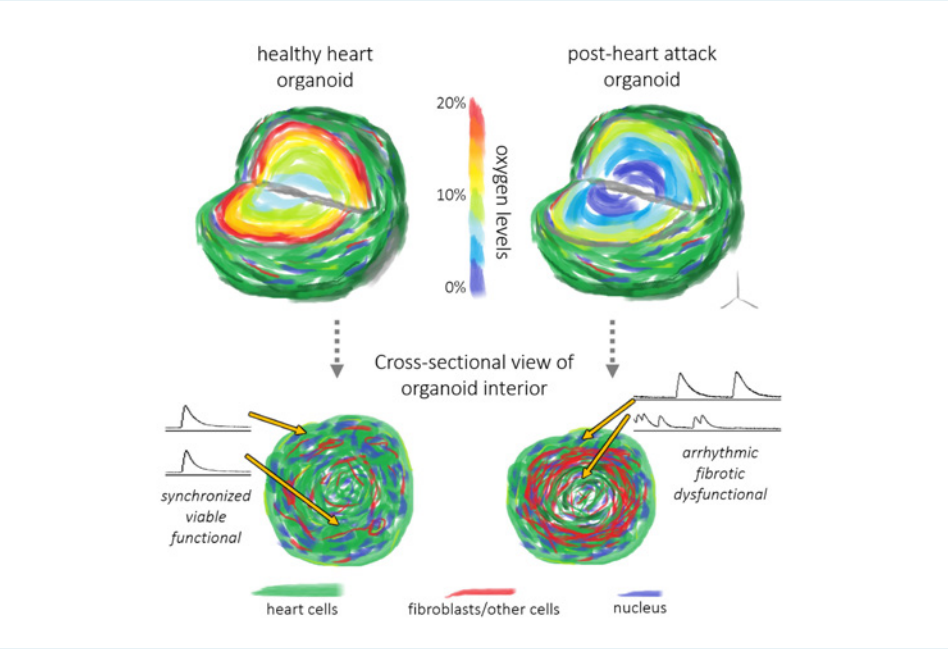


IMAGE: DYLAN RICHARDS

Low-oxygen cell culture conditions combined with human heart organoids recreate tissue-level features of a heart after a heart attack.

DISCOVERY

Heart Attack in a Dish

3D organoids give window into events immediately following a heart attack

BY CHRISTIAN JONES

In the U.S. someone has a heart attack every 40 seconds, but until now researchers have not had a model that fully mimics what occurs after that. Investigators from the Medical University of South Carolina and Clemson University recently reported in Nature Biomedical Engineering that they have developed human cardiac organoids that closely resemble the physiological conditions that occur during a heart attack.

The team was led by bioengineer **Ying Mei, Ph.D.**, who holds a joint faculty position at MUSC and Clemson University. He is part of the MUSC Clemson Bioengineering program, which places Clemson bioengineers and bioengineering doctoral students on the MUSC campus so that they can interact with clinicians in need of engineering solutions. The article's lead author, **Dylan Richards, Ph.D.**, is a graduate of the joint program.

"We were essentially able to take that 3D complex nature of a heart attack and then downsize it into a microtissue model," said Richards.

Organoids are three-dimensional multicellular tissues that are less than 1 millimeter in diameter. These organoids, or microtissues, function like their full-size counterparts. In this case, the heart organoids actually beat and contract as the human heart does. This model uses induced pluripotent stem cells, almost like "parent cells," that divide and mature into several types of heart cells that interact and self-assemble to form the organoid.

Traditionally, biologists use cells in a dish or animal models, such as mice or rats, to model diseases. Cells in a dish are great for learning things at the cellular level, but it is unnatural for cells to grow in two dimensions on a flat surface. Animal models are useful in taking the next steps toward recapitulating what happens in the human body, but organoids, especially heart ones, are the closest to recreating what occurs in humans.

Because it is very difficult to obtain a sample of tissue dysfunction immediately after a heart attack occurs, most of what we know about heart attacks comes from observations made long after the initial oxygen shortage. The organoid model fills in this gap, enabling visualization immediately after the oxygen deprivation caused by a heart attack.

"This can help us to understand better how cells respond in the short term and, in turn, how that makes way for long-term damage," said Richards.

This model also enables researchers to test whether heart drugs improve heart attack outcomes. It could also provide a way to test whether a drug that is safe in a healthy heart is also safe in a diseased one. Such information could guide physicians in prescribing drugs more appropriately in patients who had preexisting heart conditions at the time of the heart attack.

Mei intends to expand on his research by including immune cells in future studies to learn more about the role they play in restructuring heart tissue after it is damaged.

"We are not the first ones to recapitulate the cellular or even the tissue-level response. I would argue, however, that we are the first ones to recapitulate the organ-level response," said Mei.

Editor's note: Mei, Richards and their coauthors dedicate this work to their dear friend and coauthor Craig Beeson, Ph.D., who was lost to cancer before the publication of their article.

PHOTO: EMMA VOUGHT

Jessica Thaxton and her team developed a technique to monitor protein production in T cells and will use the data to explore new ways to make T cells more effective at controlling tumor growth.

DISCOVERY

Killing Cancer with Protein Production

T cells could be made into better cancer killers by increasing their protein production

BY ALHAJI JANNEH

A team of scientists from Hollings Cancer Center at the Medical University of South Carolina has developed a new flow cytometry technique that can, for the first time, quantify protein production in T cells. T cells are immune cells that surveil the body and can effectively target and kill cancer cells. However, when T cells are in the vicinity of a tumor, cancer cells sap their energy, leading to a decrease in their protein production. This change leads to T cells losing their tumor-killing ability.

The new technique can be used to monitor protein production in T cells and understand how it becomes depressed in the tumor microenvironment. Interventions could then be developed to restore T cells' protein production and ability to control tumor growth. The team, led by MUSC Assistant Professor and Hollings Cancer Center Researcher **Jessica E. Thaxton, Ph.D.**, recently reported its findings in a priority brief in Cancer Immunology Research.

"This study reveals our first attempt at trying to understand how T cells undergo the process of making proteins," explained Thaxton. "Before this paper or before this technology, scientists had very little idea how much protein T cells make. It was a shot in the dark. But now we have quantitative data, and we can begin to ask questions like, 'Which proteins?' and 'How are they made?'"

In the past four years, the team observed more than 50 human tumors, and in most tumors they noticed the existence of T cells that made very little protein. This finding led them to surmise that there are T cells unable to make proteins residing in tumors. According to Thaxton, the new technology will help them to monitor these T cells and reawaken their protein production machinery and cancer-fighting ability.

"This paper establishes that T cells able to make protein in tumors have phenomenal ability to control tumor growth," said Thaxton. "We ultimately want to remodel the existing T cell population in tumors, and that is where our laboratory is headed."

To understand protein production in T cells in tumors more fully, the scientists used two different types of signaling molecules: cytokines called IL-15 and IL-2. It has been established in other studies that T cells treated with IL-15 control tumor growth very well, but those conditioned with IL-2 do so poorly. The team found that T cells conditioned with IL-15 were able to make proteins in the tumor microenvironment and in tumors, whereas IL-2-conditioned T cells experienced diminished protein production in tumors.

These results will help scientists to understand how they can reawaken tumor T cells and increase their protein production, thereby enhancing their ability to control tumor growth. Thaxton believes that a simple strategy with a modulator that changes the way that T cells generate energy will allow T cells to experience sustained protein production in tumors and produce more effective immunotherapy treatments for patients.

Thaxton believes that the current study is the very first set of experiments that begins to delineate the role of protein production in antitumor immunity and will continue the research by studying which parts of this regulation are most important for tumor control.

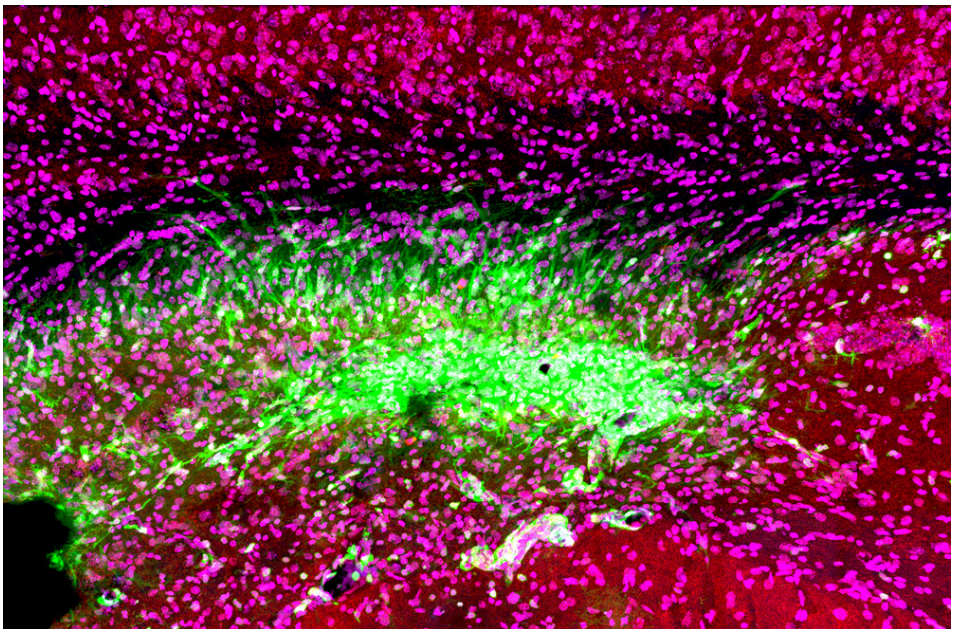


IMAGE COURTESY OF TOMLINSON LABORATORY

Even after a blocked vessel has been opened, immune cells in the brain (green) continue to attack synapses (red) and neurons (magenta) in the memory center of the brain, the hippocampus, for at least 30 days after stroke.

TRANSLATIONAL RESEARCH

Targeted Tissue Salvage on the Mind

Reducing inflammation boosts cognitive recovery and may extend treatment window after stroke

BY KRISTIN MARQUARDT

Reperfusion therapy, the gold standard for stroke treatment, helps restore blood flow after a stroke caused by a clot, preventing loss of brain tissue. However, only about 10% of stroke patients qualify, in part because of the therapy's narrow treatment window.

A recent Medical University of South Carolina study suggests that this therapy could be both safer and more effective for both motor and cognitive recovery if administered with a specialized compound that blocks the immune response. The team's preclinical findings, reported in the Journal of Neuroscience, suggest that reducing the immune response in the brain could be a strategy for improving cognitive recovery. It could also extend the treatment window for therapy, allowing stroke specialists to help many more stroke patients.

"With reperfusion therapy, we're restoring the blood flow, which is necessary to save the tissue, but there is an ongoing inflammatory response by the immune system that is not targeted by reperfusion," said **Stephen Tomlinson, Ph.D.**, a professor in the Department of Microbiology and Immunology at MUSC and senior author of the article.

This could explain why, though mechanical reperfusion has a success rate of 90% in returning blood flow to the brain, only about 40% of treated patients recover enough motor and reasoning skills within three months to tend to their daily needs independently. Even those who do recover motor function can still struggle with cognitive challenges months later.

"I've seen patients who have barely any motor deficits at follow-up, but they're really struggling in their daily life in terms of memory, behavioral consequences and language," said lead author Ali Alawieh, M.D., Ph.D., who completed his graduate studies at MUSC and is now a resident in neurosurgery at Emory University School of Medicine.

Tomlinson and Alawieh think the immune response in the brain is the culprit.

During a stroke, the oxygen and energy supply to the brain is cut off by a clot, causing brain tissue to become stressed and die rapidly.

Just as it is with a cut to the knee, the immune system is activated to heal the wound, which includes clearing dead tissue.

A family of special immune proteins called complement proteins help to guide and promote this immune response in the damaged areas.

In a 2018 article in Science Translational Medicine, Tomlinson and Alawieh showed that these complement proteins flagged both dead tissue and stressed brain cells for removal. The stressed brain cells were not yet dead, only damaged by lack of oxygen and energy. As the goal of stroke treatment

is to save as much brain tissue as possible to lessen overall damage, this was a concerning result, as it meant salvageable tissue was being destroyed by the immune system.

Therefore, Tomlinson and his team developed a complement protein blocker, B4Crry, which acts only at the site of stroke injury. This compound blinds complement proteins to the signals of stressed brain cells, saving the stressed tissue and reducing overall brain damage in a preclinical stroke model.

In the current study, Tomlinson and Alawieh hypothesized that pairing reperfusion therapy and B4Crry would significantly improve stroke recovery beyond that with reperfusion therapy alone.

In particular, they hypothesized that this combination treatment would improve cognitive recovery.

As Tomlinson's team expected, reperfusion therapy alone did improve recovery of coordinated movements such as walking in a preclinical model of stroke. With the addition of B4Crry to treatment, coordinated movement improved even faster, with greater recovery in as few as three days after stroke.

The improvements to learning and memory were even greater than those seen with motor functions.

Reperfusion therapy alone was equal to no treatment at all for learning and memory recovery after stroke. However, when B4Crry was added to their treatments, mice had greatly improved cognitive recovery, making three times fewer errors on a learning and memory task.

Tomlinson's team further probed into why the addition of B4Crry, and the subsequent reduction of the brain's immune response, aided cognitive recovery so greatly.

They found that after a stroke, brain immune cells called microglia began eating the connections between stressed brain cells. Immune system complement proteins were marking these connections for destruction because they displayed the stressed cell signal. Without these connections, brain cells cannot communicate efficiently, and overall brain function decreases.

With the addition of B4Crry to treatment, coordinated movement improved even faster, with greater recovery in as few as three days after stroke. The improvements to learning and memory were even greater than those seen with motor functions.

B4Crry concealed the cells' stress signals from the complement proteins and thereby saved the connections between neurons. Preserving connectivity improved learning and memory brain function after stroke.

A complement inhibitor such as B4Crry might also help stroke specialists overcome the biggest hurdle for reperfusion therapy: the short treatment window.

Tomlinson's team showed that adding B4Crry to reperfusion therapy after clot removal reduced the potential for hemorrhage, even with treatment given up to six hours after stroke. These findings suggest that complement inhibition could not only make reperfusion therapy safer but also extend its treatment window, making it available for many more stroke patients.

Alawieh is excited about the future use of complement inhibition in the clinic.

"Our next step is to see how complement inhibitors work with comorbidities, such as old age, smoking and diabetes, in a preclinical study," he explained. "Collectively, this information will help us design the best clinical trial when we move to humans."

Tomlinson's team at MUSC is also testing the potential for complement inhibitors in other brain injuries, such as traumatic brain injury.

"We have shown that we can administer complement inhibitors as far as two months after a traumatic brain injury and see improvements in cognitive recovery," said Tomlinson. "This is something I'm actually quite excited about. It means that months after an initial event, complement inhibitors could still be beneficial to cognitive recovery after brain injuries, including strokes."

A New Kind of **Hybrid**

MUSC Health nurse anesthetist Brady Thomas works in the new operating room.

Partnership between innovative physicians and Siemens Healthineers brings a new operating room to MUSC Health

BY CELIA SPELL

Space and technology come together to create the optimal surgical environment in MUSC Health's new hybrid operating room.

In this new state-of-the-art OR, physicians can perform both open and laparoscopic procedures on the same patient during the same visit, which lessens the patient's need for multiple rounds of anesthesia and lowers overall risk. **Ravikumar Veeraswamy, M.D.**, director of the Division of Vascular Surgery, worked with fellow MUSC heart and vascular surgeon **Marc Katz, M.D.**, director of the Division of Cardiothoracic Surgery, and interventional cardiologist **Daniel Steinberg, M.D.**, the Michael R. Gold Endowed Chair in Structural Heart Disease, to design an operating room that would provide a space for these surgeries.

"Collaborating on this project was a natural fit for us," Veeraswamy said, referring to his two colleagues. Accustomed to working together on patients and offering solutions, as well as sharing new techniques from their own areas of expertise, Veeraswamy, Katz and Steinberg were excited for this opportunity. After more than a year of meeting with each other and with MUSC's strategic partner, Siemens Healthineers, the team brought the room to life.

What Veeraswamy finds most useful about this new room is its imaging capabilities. With the most up-to-date technology, surgeons and interventionalists in this operating room can visualize more of the surgical field ahead of surgery. By combining ultrasound imagery with X-ray imagery, physicians can see everything more clearly — like upgrading to a high-definition TV. And this imaging can even be captured through the table the patient is lying on.

Ultrasound imagery is ideal for capturing movement and tissues, according to Steinberg, while X-rays capture changes in density. "By being able to merge the two, you can look at one picture that has the advantages of two," he said, "which helps us perform more minimally invasive procedures on our patients."

Patients with complex aortic pathologies are great candidates for this operating room, and Veeraswamy points to an endovascular stent replacement as a surgery that utilizes the technology to its fullest extent. By keeping the procedure as minimally invasive as possible, while also allowing the physician the opportunity to transition to an open procedure if needed, surgeons can tackle problems that were once thought too complicated. They can also expose the patient to less radiation and less anesthesia, both of which contribute to the risks involved with any surgery.

One drawback to technology is that it is always evolving, and it doesn't always take much time for it to become obsolete. But the physician team at MUSC Health worked with Siemens Healthineers to prepare for that possibility by making sure the room was adaptable as well as flexible. It can change as technology does, and Siemens Healthineers is prepared to incorporate technological upgrades like augmented reality and other updated software.

"This strategic partnership is ultimately about patient care," says Dave Pacitti, President and Head of the Americas for Siemens Healthineers. "By empowering MUSC with the technology they need as patient care evolves, we hope to help their clinicians do even more for their stroke patients and improve poststroke outcomes."

Between its teamwork capabilities, technological advancements and efficient design, the new hybrid operating room gives surgeons at MUSC Health the ability to help more patients. It also gives medical technology a space to thrive.

PHOTO: SARAH PACK

PHOTO: ISTOCK

Four of every five Americans take a daily medication, and one in three take more than one, so MUSC Health incorporates pharmacists to help patients take their medications appropriately and avoid adverse reactions.

Putting Adverse Reactions **Back on the Shelf**

Health care teams at MUSC incorporate pharmacists to help with medication safety and adherence

BY CELIA SPELL

Blood thinners can be vital to a person's health after a heart attack, but they cannot be taken alongside certain over-the-counter painkillers like ibuprofen or aspirin. Both medications affect the blood's ability to clot and in conjunction can increase the risk of bleeding.

If not taken correctly, they can make a minor injury much worse.

As the population continues to live longer and as we continue to discover more uses for certain medications while also developing new ones, the risk for adverse reactions increases. Four of every five Americans take a daily medication, and one in three take more than one, according to the Centers for Disease Control and Prevention.

In an effort to improve the medication safety of its patients, MUSC Health incorporates pharmacists into its interdisciplinary health care teams. **Gus Katsanevakis, Pharm.D.**, an outpatient pharmacy coordinator at MUSC, works with each patient to ensure that the dosage of a medication is appropriate and that each new medication can be taken with a patient's current medications.

Some medications are dosed based on the patient's weight. With the most current weight, Katsanevakis can double check the dose needed and be sure they go home with the right dosage. In addition to weight-based dosing, Katsanevakis checks other factors, such as a patient's kidney function or the potential for interactions with other medications he or she is already taking.

Cat Rigdon, Pharm.D., works alongside Katsanevakis as a clinical pharmacist at MUSC, and she points to medication administration as another important avenue for patient safety. Injectable medication, for example, can lead to poor outcomes if not used correctly or disposed of appropriately, so health care teams at the hospital work with their patients to teach them the right procedure. When prescribing a new medication, Rigdon and her team look for each patient's skill set and adapt towards that, often repeating training with their caregiver to ensure success.

"By counseling patients and their families on the right time to take a new medication in conjunction with their preexisting regimens, we can limit drug-drug interactions as well as decrease side effects that could cause the patient to stop taking their medications," Rigdon said. "We want to keep our patients healthy by optimizing each therapy and providing the ideal environment for absorption into the body."

These unique practices are part of hospital pharmacies like that at MUSC. MUSC pharmacists work as part of the patient's medical team and have immediate access to their physicians. Katsanevakis and Rigdon can also work with their team to find a less expensive medication or one covered by the patient's insurance. If a patient is unable to afford a medication, they are less likely to continue taking it, so it is important to find a medication that works for their health that they can also afford.

Another way MUSC helps patients with medication safety is by filling their prescriptions before they leave the hospital, which is part of a larger national program known as Meds-to-Beds. Sending a patient home with their medications provides an easier and healthier transition to normal life after their hospital stay. There could be many reasons for a delay in picking up a medication after leaving the hospital. An outside pharmacy might be closed or need more time to fill a prescription. There could be issues with insurance or needing extra physician authorization, or a patient may be unable to drive themselves to that pharmacy.

By incorporating pharmacists into their health care teams, MUSC can resolve these issues before a patient is discharged, which allows a patient to ask any questions and take their first dose of medication immediately and appropriately.

Katsanevakis points to insulin as an example. There may be multiple reasons a patient is unable to pick up a prescription after leaving the hospital, but if they don't take their insulin as prescribed that day or the next day, they could end up back in the hospital. With a program like Meds-to-Beds, patients are more likely to take their medication as prescribed. Patients will also often have more than one doctor taking care of them while in the hospital, so hospital pharmacists will review their medications to make sure they all work well together and will contact the doctors to make any needed changes.

Patients can help their health care teams prescribe the correct medication by knowing the names of the prescriptions they already take each day. If a patient takes multiple medications, Katsanevakis suggests writing them down so that any new physician knows exactly what is already in their system. It's also important for patients to take medications as prescribed, whether that be with food or twice a day. Following these prescribed instructions allows the medication to be as effective as possible and helps health care teams take better care of their patients.

"Medication safety is incredibly important for patients," said Katsanevakis. "It's a continuous problem, but we are moving in the right direction by giving pharmacists a seat at the table."

Rami Zebian, M.D., is chief medical officer of the MUSC Health Florence and Marion Medical Centers.

Allies in the War Against COVID-19

MUSC Health Network joins forces to study COVID-19 across South Carolina

BY KIMBERLY MCGHEE

As MUSC Health leaders began to plan for the onslaught of COVID-19, they thought that Charleston would see the highest increases in hospitalizations in South Carolina. Instead, some of MUSC Health's regional hospitals were the hardest hit. For example, early in the COVID-19 pandemic, MUSC Health Florence Medical Center had one-fourth the patient census of MUSC Health Charleston but four times the number of COVID-19 cases.

From the start, MUSC Health opted to take a "systems" approach to COVID-19, according to **Rami C. Zebian, M.D.**, chief medical officer of the MUSC Health Florence and Marion Medical Centers.

"We said that, as a system, we don't know where COVID-19 will strike hardest, but we have to be ready to mobilize resources, anywhere in the system," said Zebian.

Although MUSC Health has provided regional hospitals with the necessary resources to face the crisis, frontline health care workers, like their fellow caregivers across the nation, keenly felt the lack of treatment options to offer patients against this new foe.

"It's hard for me as a physician and for the medical staff in general to see someone get severely ill and feel that you are helpless, that you don't have much to offer," said Zebian. "When we have a new disease, often the only things that are available are experimental therapies offered through clinical trials."

Zebian had been encouraged by MUSC Health leadership at every turn to ask for what he needed. So when he heard that a convalescent plasma study had opened at MUSC Health Charleston, he picked up the phone to ask whether it could be brought to Florence. The study was testing whether antibodies in plasma from patients who have had COVID-19 can help patients with severe COVID-19 fight the disease better.

On the other end of the telephone call were leaders at the South Carolina Clinical & Translational Research (SCTR) Institute. SCTR is one of more than 60 Clinical and Translational Awards hubs nationwide dedicated to speeding the translation of research breakthroughs into the clinic. Last fall, Zebian met with SCTR leaders, including SCTR co-principal investigator **Patrick Flume, M.D.**, to discuss opportunities for expanding the availability of clinical trials.

Expanding clinical research to the regional hospitals and to rural areas is one of the goals of SCTR, which was just awarded a five-year grant renewal to continue its work. To meet that goal, it had already been working to build the infrastructure to conduct trials remotely. Those efforts ramped up during the COVID-19 lockdown, when many traditional trials adapted to a virtual format.

"When COVID hit, that was an accelerant," said Flume.

So when SCTR received Zebian's call, a number of research teams jumped into action to field potential COVID-19 trials and assess their fit for the regional hospitals, to help gain approval for the trials, and to run the trials.

"Our team is staffing these trials seven days a week to make this happen," said Ashley Warden, clinical research manager for the MUSC Pulmonary and Critical Care Clinical Research program. "We are helping regional sites to enroll patients into the trials while also providing support to the physicians in Charleston who are running the trials here."

"It's really been a collaboration of a bunch of people who understand it, are passionate about it and made it work," said Flume.

"The MUSC and SCTR teams were very helpful and embraced us," said Zebian. "They told us that there's no difference between doing clinical trials in Florence and in Charleston. We're already doing it via tablets or remotely or signing in via telemedicine. So it doesn't matter where the patient is."

Within weeks, MUSC Health Florence Medical Center began enrolling its first patients into the convalescent plasma study. Soon after, patients from Marion and Lancaster also began receiving plasma. By August, when the U.S. Food and Drug Administration issued emergency authorization for convalescent plasma and the trial was closed, more than 346 patients from the MUSC Health system had been enrolled.

"It's unbelievable when I look back at where we were a few months ago, when we just hoped that one day we might have research or clinical trials. And now, at Lancaster and Marion, a lot of people have designated research roles. That would not have been possible without the health system and without SCTR's support," said Zebian.

Currently, COVID-positive patients in Florence and Charleston can donate blood and saliva to the SCTR COVID-19 biorepository, a collection of specimens that researchers can use to better understand the disease and how to combat it.

SCTR is continuing to review and open new COVID-19 trials in Charleston and at the regional hospitals. It carefully vets potential trials, according to Flume, to choose those that show the most promise and are the best fit for the needs and the resources of the area.

Flume said, "We want to bring hope and real opportunity. And when you have something that actually hits and works, it's a major home run. You know that you can bring something to these people, and our commitment is to the people that we serve in the state of South Carolina, not just Charleston."

And SCTR's dedication to serving the citizens of South Carolina will not end with COVID-19, according to Flume. The relationships and research infrastructure currently being built will make it easier to conduct clinical trials on other health problems being faced by local communities, such as the opioid crisis and high levels of smoking.

"I think that the relationships we're building during the COVID-19 crisis show that we're fully invested with our regional sites," said Flume. "We need for them to be the front line, and we've got the infrastructure for these types of studies, and we'll work together to make that happen."

Zebian could not agree more.

"We are starting with COVID-19, but we're not stopping there," said Zebian. "Adding clinical trials to the arsenal of treatments for many diseases here at MUSC Health Florence Medical Center will be a huge win for the community."

For more information on active COVID-19 trials, visit https://research.musc.edu/clinical-trials/coronavirus-clinical-trials.

PHOTO: KATHRYN VAN AERNUM

THE HIGH-DEF Surgical Suite

Holistic 3D perspective transforms neurosurgery and kicks off collaborative partnership with Synaptive

BY LESLIE CANTU

An industry partnership means doctors and researchers at the Medical University of South Carolina not only will have access to groundbreaking technologies to improve patient care but also will have a hand in developing uses for these new tools that could ultimately aid patients across the continent.

MUSC and Synaptive, a medical device and technology company based in Toronto, Canada, signed a five-year affiliation agreement earlier this year as the culmination of several years of discussion. The agreement brings two Modus V 3D robotic digital microscopes to MUSC Health, making the new MUSC Shawn Jenkins Children's Hospital and Pearl Tourville Women's Pavilion the first pediatric hospital in North America to own and operate with the 3D scope system. The full Synaptive system, which has been in place at the children's hospital since its opening in February, is now also installed in an adult operating room at MUSC Health University Hospital, and plans are underway to also bring Synaptive's imaging technology to the Charleston hospital.

But calling the Modus V simply a "new microscope" would be like calling smartphones just newer versions of landlines, said **Sunil Patel, M.D.**, chair of the Department of Neurosurgery. When they debuted, smartphones were seen primarily as a means for people to communicate via calls, email or text. Today, with the explosion of third-party apps and faster internet connections, people can use their phones to shop, play games, watch TV, get real-time driving directions, visit the doctor and even do their schoolwork.

Patel said the Synaptive technologies will enable the same sort of explosion of uses in surgery — and MUSC will be working with Synaptive to develop those uses.

"This is an instrument that's going to have a lot of other applications, and it's going to need modifications," he said.

Pediatric neurosurgeon **Ramin Eskandari, M.D.**, first saw Synaptive's technology during a conference five years ago and was immediately drawn to the possibilities. He alerted MUSC Health leaders, and a subsequent group visit to Synaptive headquarters to look at the technology in development blew everyone away, he said.

Now, MUSC Children's Health is the first children's hospital to begin using Synaptive's integrated suite of technologies, which includes the Modus V 3D robotic digital microscope in conjunction with its planning software and navigation system, according to Synaptive president and cofounder Cameron Piron.

Piron said his team was inspired by conversations with surgeons as well as watching surgeons in action. Having already begun work on rethinking the MRI, they saw the physical limitations of traditional viewing devices like microscopes, loupes and endoscopes, not to mention the visual limitations, and realized the two types of technologies weren't working together as well as they could.

"What we recognized is those two worlds were not fused together. There's this really awkward handoff happening in the operating room, where you're diagnosing with MRI and then handing over to optics, and there was no way to bring those two worlds together. That became a really obvious challenge," he said.

Neurosurgeons already plan out their surgeries using tractography, a modeling technique that shows the nerve tracts in the brain by using MRI images, Patel said. But during the actual surgery,

PHOTO: BRENNAN WESLEY

Ramin Eskandari, M.D., performs surgery using a Modus V digital robotic exoscope. With this device, he can look up at a screen instead of down into microscope eyepieces.

he said, "When you look at the tissue of the brain, it doesn't have labels on it." That, he added, changes with the Modus V.

"Now when you're looking at the screen, you see the brain live, but superimposed on it is all these labeled highways of nerve fibers. It also superimposes on the image you're seeing where the tumor is or where the lesion is. Now when you're operating, you're actually able to see on the screen exactly where those functional tracts are in relation to the surgical path or lesion," Patel said. "This will improve surgical outcomes by avoiding neurological deficits and allowing the surgeons to remove the lesion completely and safely."

The Modus V microscope also tackles some basic logistical challenges of the operating room. Instead of the surgeon having to move it by hand to get the right view, the Modus V responds to voice commands and tracks the location of the surgeon's hands via navigated surgical instruments.

But the most elemental difference is the view it provides.

"You can see everything from the skin layer all the way down to the depth of the brain tumor — all in focus, all at the same time — and that's never been done before," said Eskandari, who has used the system in about 30 surgeries and is coauthoring a white paper about the experience with surgeons from Stanford Children's Health who have been using the 2D Modus V system.

Eskandari explained that with traditional microscopes, the surgeon is looking through a viewfinder quite similar to the microscope that most people are familiar with from high school biology. There are several drawbacks to this during surgery, though. First is that it reduces the surgeon's field of view to only what is directly in front of the microscope. The surgeon doesn't see the larger surgical site or even what is going on in the operating room.

Secondly, the microscope looks only where the surgeon's head is facing. Eskandari used as an analogy the example of someone sitting in front of a computer looking down at the keyboard. Put a microscope up to your eyes, and what do you see? Still the keyboard, except in greater detail.

But what if you wanted to see the back of the computer monitor? You'd have to place the microscope behind the computer, where

it wouldn't do you a bit of good unless you also got up and moved behind the computer.

With the Modus V, however, Eskandari can maneuver it to look at the surgical site from any vantage point while he remains in his original position. The Modus V's 3D heads-up display is shown on a large 4K screen visible to everyone in the room.

"That took some getting used to. But once you get it, now you're using the camera in ways that you physically would never have been able to before, even with a microscope," he said.

"Calling the Modus V simply a 'new microscope' would be like calling smartphones just newer versions of landlines." —Sunil Patel, M.D.

Furthermore, not having to crane their necks over microscope eyepieces for hours makes surgeries physically more sustainable for surgeons, he said, noting that he recently completed an eight-hour tumor surgery.

"Usually by the end of those cases, your neck is just dying, your head hurts, your eyes hurt because you've been looking through a microscope for 'x' number of hours. You've been in all kinds of contorted positions, or you're having to turn the patient into all kinds of contorted positions in the operating room on the table, which is also not good," he explained.

Put all that together — better visuals with more detail and a larger field of view that is visible to everyone working on the surgery, along with improved ergonomics — and the result is better outcomes for patients, Eskandari said.

It's simple — the better view that surgeons have, the better they can do their job. Patients see the results with increased options for surgical intervention, shorter surgeries and quicker recoveries. Just recently, Eskandari said, he was able to remove a tumor from deep in a child's brain by performing surgery through a half-inch tube, utilizing only a small incision in the child's eyebrow. The youngster was able to go home three days later.

Although the technology was developed with neurosurgery in mind, Patel believes other specialties will want to use it as well. This takes medicine one step closer to true robotic surgery, he said.

The realization of what the technology can do has sparked a long list of ideas of things to try. **Kevin Gray, M.D.**, assistant provost for research advancement, is one of the people on a joint oversight committee who is charged with ensuring that this creative innovation remains at the forefront of the partnership.

In years past, Gray said, a relationship with a medical device company would be more transactional: Either the hospital wanted to buy equipment, or the company wanted to test its equipment in a hospital setting — and any hospital would do. The partnerships that MUSC has entered into in recent years have instead emphasized working together to develop new techniques and devices that ultimately can improve patient care, he said.

"The purpose of this innovative approach to partnerships and the role of the joint oversight committee is to ensure we don't slip back to a transactional relationship. We have to keep challenging the status quo to make sure we're innovating in a complex health care system," Gray said. That includes ensuring that the partnerships focus not just on clinical care but also on research and education, he said.

"We can answer questions that Synaptive has, but we can generate questions they may not have thought of — clinical scenarios they didn't realize are really important to us," Gray said.

Jesse Goodwin, Ph.D., chief innovation officer for MUSC, is part of the joint innovation subcommittee with Synaptive that ensures research proposals are aligned with MUSC and Synaptive's mutual goals. In addition to expanded uses for the technology, Goodwin expects that surgeons and Synaptive will work with the Zucker Institute for Applied Neurosciences at MUSC to develop new medical devices that will work with the technology.

"It's been great working on a partnership where there are so many ideas bubbling up from the operating rooms," Goodwin said.

Surgeons aren't the only ones who are excited, though. There's also a great deal of excitement about the possibilities offered by an MRI developed by Synaptive that allows imaging directly at the point of care in critical care settings. Synaptive and MUSC are working to add the MRI, which received U.S. Food and Drug Administration clearance in April, into the research and clinical innovation mix.

MRI stands for magnetic resonance imaging, and for years, bigger has meant better. Bigger magnets yielded better images. The typical MRI machine weighs somewhere around 10,000 pounds and requires a 1,000-square-foot room, Piron said. That means it can't be placed just anywhere in the hospital. The floor has to be reinforced to handle the weight. Plus, the room has to be shielded.

"You can't have this powerful magnet sitting on the third floor — everybody's wallet or necklace is going to be stuck to the floor or wall. So every time you put in an MRI, you've got to build a room with shields so that the magnetic field doesn't get out," Patel said.

Nor is the MRI particularly patient friendly, Piron said. It's loud, it's

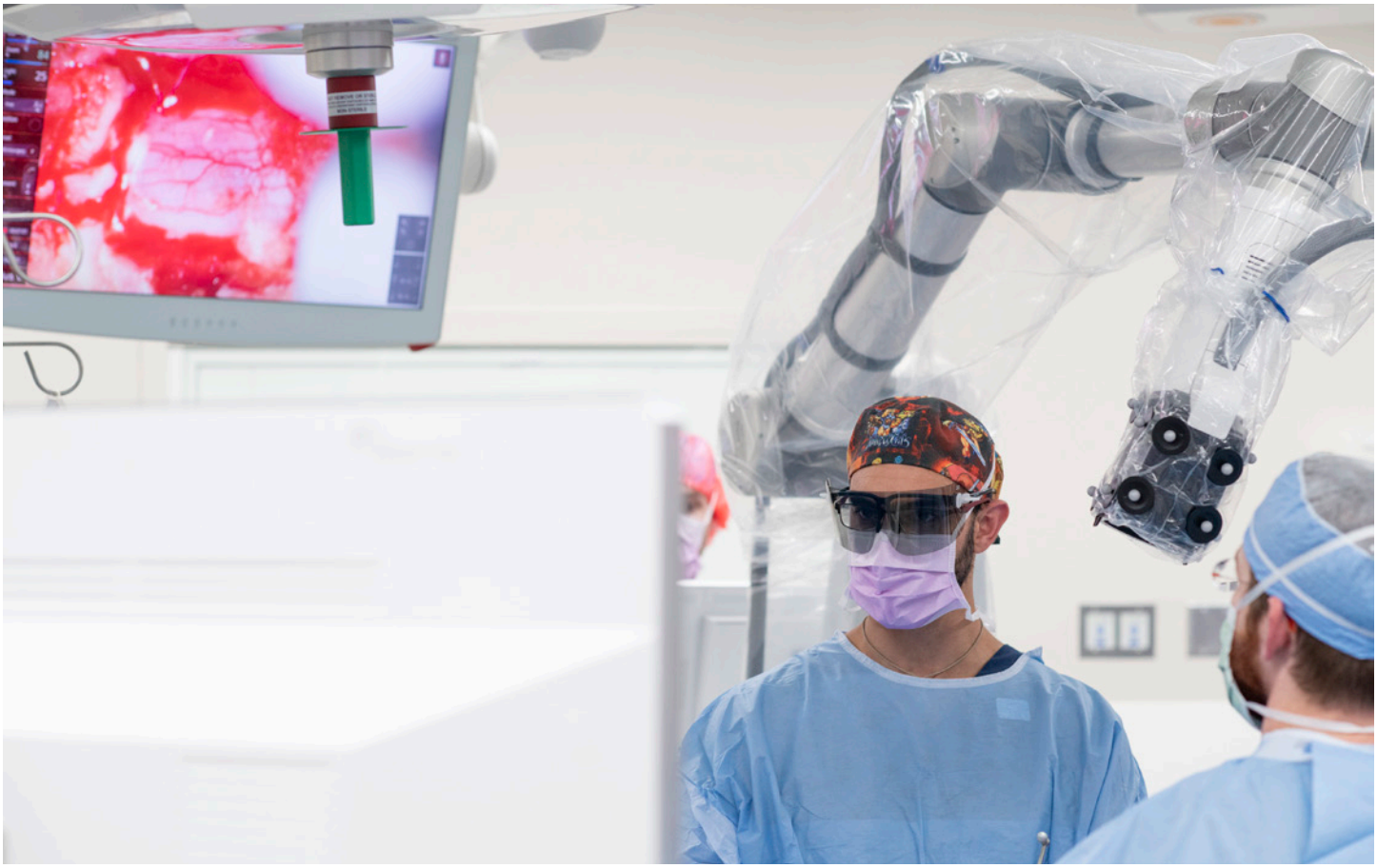


PHOTO: BRENNAN WESLEY

Eskandari uses the 3D view on the screen during surgery.

claustrophobic and it can be problematic to use when patients have implants. Most low-field alternatives are more patient friendly, but with the trade-off of lower-clarity images.

Piron's team decided that rather than making the magnet even bigger and stronger, they would instead make the magnet smaller and weaker and concentrate instead on improving the receptor to amplify the signal and produce quality images, specifically of the head area. They chose to aim between the high-field and low-field MRIs currently on the market, reducing the magnetic field enough that it doesn't require shielding or complicated maintenance.

"We get imaging that is astounding and consistent in a smaller platform and better price point," Piron explained. "We're really excited about that, because no one has really pursued this area."

The smaller magnet means a smaller machine, which has a number of practical applications. Because it weighs only about 2,000 pounds and can be placed in a 250-square-foot room, hospitals have more flexibility about where to locate the MRI and can situate it closer to emergency departments or ICUs, Piron said.

Aside from offering more options in clinical care, the weaker magnet also enables more opportunities for research. Gray, a psychiatrist who is part of a national study that scans adolescents' brains to understand normal development, said he can envision multiple uses for such an MRI in both clinical and research settings.

"One of the ideas is imaging brain development of premature infants and getting a better understanding. There's not a lot of data now because it wouldn't be safe to take them to an MRI suite," he said.

Goodwin noted that, if MUSC and Synaptive move forward with adding the MRI here, it would be a good fit for stroke research happening at MUSC. As for the Modus V scope, there's no shortage of ideas coming from the surgical team for both research and medical devices, she said.

Piron said Synaptive is just as enthusiastic about the partnership as MUSC.

"It's a very important partnership for us because it's the first partnership that will be working across all our products," he said. "We just see such an alignment in vision of how imaging and automation and robotics can be integrated to offer not just better care for the patients but better care across the health care system."

Ramin Eskandari, M.D., and his team perform an intricate spinal cord detethering procedure on a young child.

Through the 3D Glass

A spinal cord detethering case demonstrates how the clearest vantage point protects both surgeons and their patients

BY SHAWN OBERRATH

To see firsthand the advantages of the Synaptive Modus V digital microscope detailed in "The High-Def Surgical Suite," Progressnotes observed the machine in action during a procedure performed by pediatric neurosurgeon **Ramin Eskandari, M.D.**, and his team.

In this procedure, Eskandari performed spinal cord detethering and fluid pocket release on a 15-month-old child. Tethered spinal cord syndrome is closely associated with spina bifida but can also have other origins, such as lipoma, a thickened filum terminale (a normally delicate filament that supports the lower end of the spinal cord) or a history of spinal trauma. Whatever the cause, as the patient grows and the spinal cord lengthens, the nerves within stretch and can be injured. Surgical intervention releases the tissue attachments holding the cord in place, thus allowing normal movement as the child grows.

While spinal cord detethering itself is not a new procedure, Eskandari's novel approach uses a powerful combination of

coordinated imaging and advanced robotic technology to provide an unparalleled vantage point. This promotes the safest possible outcomes for both patient and surgeon.

Strategy came into play from the beginning — well before the operating room. First, the baby needed to be old enough to safely undergo surgery but young enough that the tethering had not yet done nerve damage.

Eskandari explained, "Our ability to perform the operation safely increases as they get older, but we also wanted to find a happy medium between doing it early enough and doing it too late. So we picked about a year because that allows us to remove the bony portion of the back of the spine and replace it at the very end, because the bone has grown enough."

The surgical team used a collaborative imaging plan to keep the child safe during surgery, beginning with an MRI-guided needle puncture to specify the exact surgical location.

PHOTOS: BRENNAN WESLEY

Next, the surgical team went to work on a step-by-step visualization plan. The patient began in the MRI room, where a neuroradiologist marked the exact spot of the operation with a small needle puncture. The location on the back was in an area with no obvious anatomical markers, so having a precisely marked target was essential.

The patient was then moved to the operating room, where a neurophysiologist placed electrodes in planned locations to allow for nerve monitoring throughout the procedure.

This step was crucial according to Eskandari: "This allowed us not only to be safe but also to be appropriately aggressive so we could make holes and cuts where we needed to release the spinal cord, knowing that the neurophysiologist was continuously monitoring the nerves so we didn't accidentally cut something we didn't want to."

With all prep work in place, the procedure began. The surgeons removed a tiny piece of vertebral bone to reveal the dura and then used high-power ultrasound to verify the location.

At that point, Eskandari began working with the Modus V microscope, also called an exoscope. He donned his 3D glasses, opened the dura and then released the spinal cord attachments and the fluid pocket, using the full zoom capabilities of the machine. The instrument can zoom to about 12.5 times normal vision, which far exceeds what even the newest conventional microscopes can manage. Because being a pediatric surgeon means that everything on the patient is small, Eskandari was the first surgeon in the nation to use the exoscope to its maximum capacity in this way.

But beyond mere magnification, the 3D capabilities of the exoscope are where it shines.

"It allows you to see tissue definitions much more clearly and distinguish between different planes of tissues, especially when it comes to things like brain tumor cases or spinal cord tumors. The camera is above you, and the entire operating field is in focus. It's almost impossible to hit anything or accidentally injure anything because everything is obviously in focus and you don't lose your peripheral view."

To complete the procedure, the spinal cord opening was closed, and the bone was replaced by use of an absorbable system.

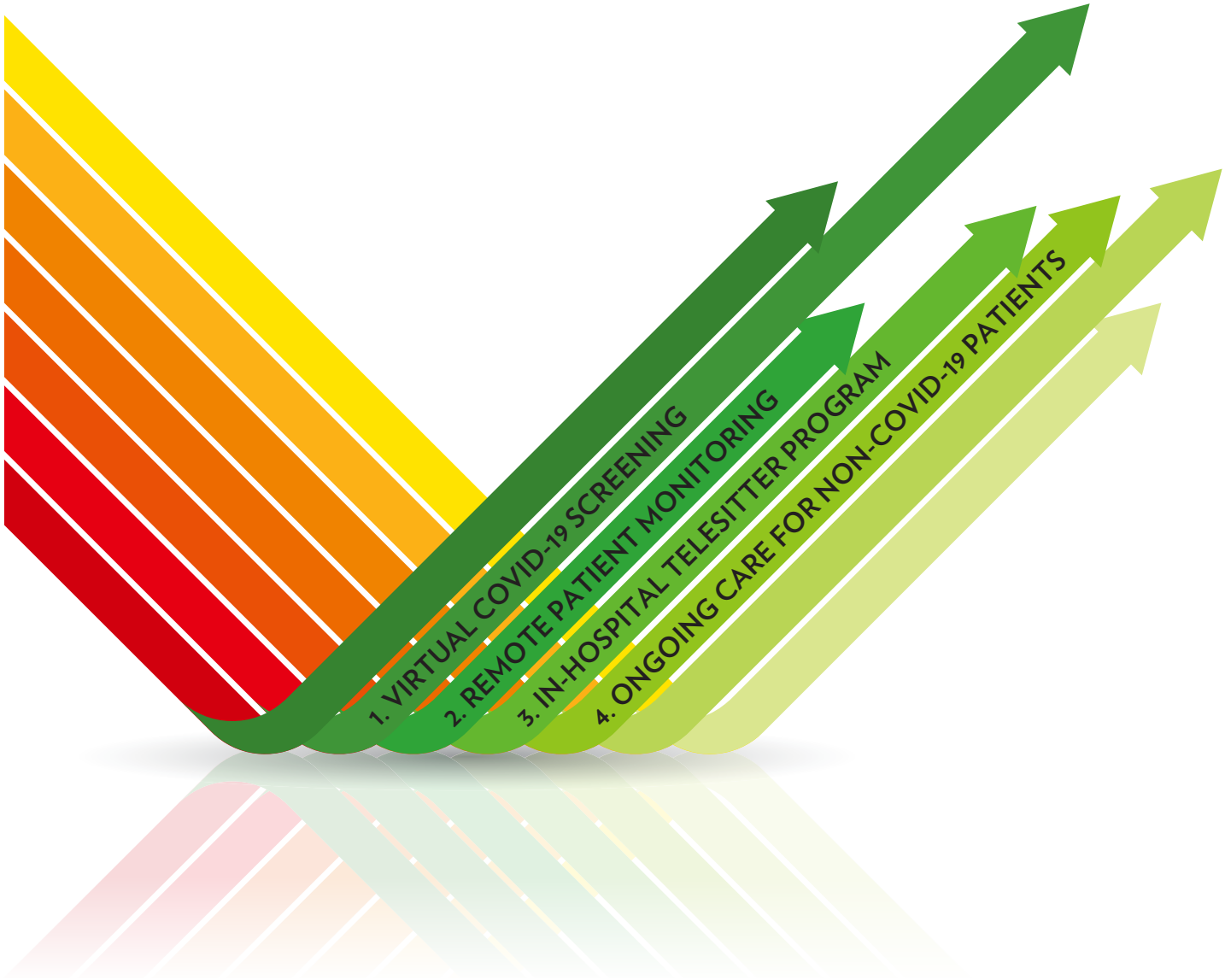
Eskandari was thrilled to report that the patient did very well after surgery. He said, "The day that the patient left the hospital she was running around in her room and smiling and had no pain whatsoever."

Not only that, but Eskandari was able to leave the operating room pain-free as well:

"This exoscope has 3D capabilities, so we can put on our 3D glasses and look onto a gigantic monitor in a very ergonomic way and see into the patient without ever having to look down."

And since fatigue is a very real factor that affects a surgeon's technical skills as a procedure winds on, a comfortable surgeon is great news for both patients and surgeons.

Visit the MUSC Health Medical Video Center to see further details and footage of the procedure.



Pandemic Pivot

Telehealth rapidly scales up during the COVID-19 pandemic to provide care to patients in the safety of their homes

BY KIMBERLY MCGHEE

Hailed for its ability to erase distance between health care providers in cities and patients in rural areas, telehealth has ironically enabled medical care to continue in a time when we all must keep our distance.

Across the country, telehealth use has spiked as providers offer virtual patient visits to ensure medical needs are met while minimizing COVID-19 exposure. Regulatory agencies have loosened some restrictions on telehealth during this crisis, and more and more payers have begun to reimburse for it as they would for any other medical service.

The Medical University of South Carolina, one of only two Telehealth Centers of Excellence nationwide, quickly mounted a four-pronged response to the COVID-19 pandemic that ensured both continuity of care for patients with suspected or confirmed COVID-19 and continued outpatient care for all other patients. The team of telehealth and bioinformatics experts who led the effort documented their approach and its success in a recent article in the Journal of the American Medical Informatics Association.

Early on, MUSC Health and telehealth leaders saw the need for a coordinated response to the pandemic.

"The same realization was coming to the forefront of the minds of the leadership in telehealth, myself included, that this was going to be a big problem," said **Dee Ford, M.D.**, director of the MUSC Telehealth Center of Excellence and lead author on the article. "We needed in our own way to create some kind of response to what we believed to be a pretty significant public health problem. Planning started before we even had a case in the state."

Very quickly, MUSC Health was able to stand up virtual screening of patients with suspected COVID-19 and mobile testing sites across the state, a remote home-monitoring program for patients with less severe COVID-19 and a telesitter program for hospitalized patients that enabled providers to monitor and communicate with patients via an audiovisual monitor, minimizing their exposure and preserving personal protective equipment.

It was able to do so in part because it had long been building its telehealth and bioinformatics capacity. With generous funding from the state, the MUSC Health Center for Telehealth, in coordination with the South Carolina Telehealth Alliance, has been expanding its telehealth services throughout even the remotest regions of the state.

"The state of South Carolina made an investment in MUSC years ago to develop telehealth programs, which then led to a high state of expertise and readiness to pivot when COVID-19 arrived," said **Patrick J. Cawley, M.D.**, CEO of MUSC Health. "The MUSC Health Center for Telehealth is to be congratulated for this ability to lead during this crisis."

Since 2012, when MUSC Health adopted EPIC, an electronic health record (EHR), the MUSC enterprise has continued to recruit bioinformatics researchers, mainly housed in the Biomedical Informatics Center (BMIC) and Information Solutions, to customize EPIC to the health system's needs and to learn how to improve care by analyzing EHR data.

Existing telehealth tools would prove invaluable to the initiative, but they had to be radically reimagined and integrated for the purpose of responding to COVID-19. Realizing that the scale of the effort would require easy-to-use options, telehealth leaders also onboarded some new tools, such as the user-friendly telemedicine platform doxy.me, created by BMIC researcher **Brandon Welch, Ph.D.**

"We had a battlefield-type mentality that we had to all get together to form a new structure," said **James McElligott, M.D.**, executive medical director of the MUSC Health Center for Telehealth.

As they worked to build a unified response and fashion existing tools to be COVID-19 relevant, telehealth leaders had the full support of hospital leadership, their colleagues in bioinformatics and the South Carolina Clinical & Translational Research Institute, which provided technical and logistical support.

"No one ever said no, even if that meant working for five months straight and into the late hours of the night and calling up Bioinformatics and saying, 'Make this work like this or change it like this,'" said article coauthor **Kathryn King, M.D.**, codirector of the MUSC Telehealth Center of Excellence. "No one ever said no because I think we just knew that it had to happen."

MUSC Health chief research information officer and BMIC director **Leslie Lenert, M.D.**, who is senior author of the article, is proud of his bioinformatics team, which put research aside for a time to help meet this urgent clinical need.

"We took the research capacity we had for EPIC support and improvement, and we told them to stop, and we put them on this full time. That's why we were able to respond so fast," said Lenert. "So we took our best people, and we put them on this problem immediately. We protected their time, and we told them to get something done. We started early, we committed absolutely and we worked with our clinicians to solve practical problems that they had."

With BMIC's help and SCTR's support, existing tools were quickly revamped to ensure care for patients with suspected or confirmed COVID-19 and continued ambulatory care for all other patients.

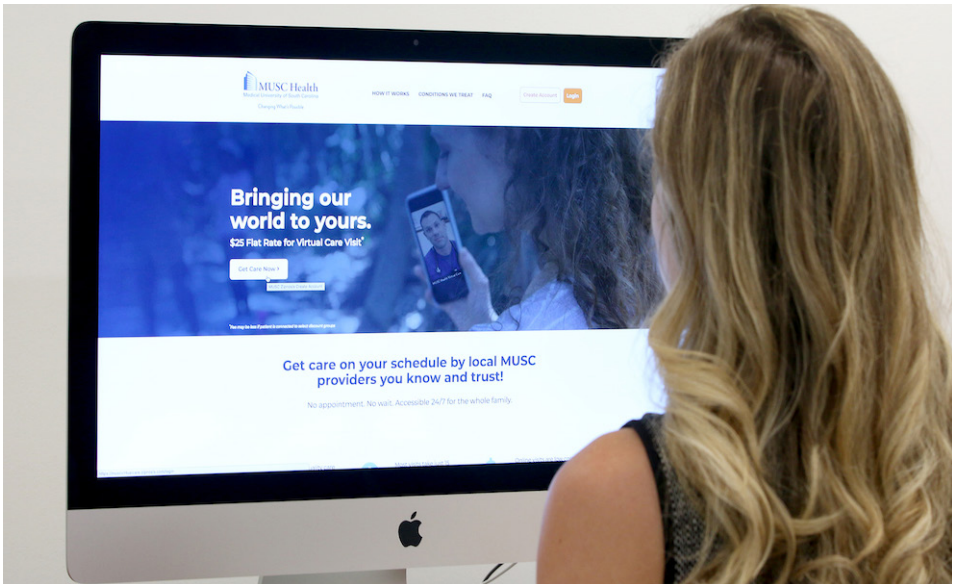


PHOTO: SARAH PACK

The MUSC Health Virtual Urgent Care service is offered for free to patients being screened for COVID-19 testing.

Virtual urgent care

Virtual urgent care technology, meant to provide patients a convenient way to be seen for minor illnesses, had to be adapted into a platform for screening patients with suspected COVID-19 and scheduling appointments for them at mobile testing sites throughout the state. Previously, patients reporting serious symptoms, such as shortness of breath, would have been kicked out of that system; therefore, **Edward O'Bryan, M.D.**, telemedicine director for the Emergency Department and direct-to-consumer and institutional telehealth at MUSC, along with other telehealth leaders, had to work rapidly with the virtual urgent care vendor to adapt the technology to screen for COVID-19 symptoms.

At the same time, they had to begin staffing up to meet the anticipated demand, increasing the number of providers dedicated to virtual urgent care from fewer than ten to more than a hundred. O'Bryan estimates that more than 150,000 patients have now been screened for COVID-19 through the modified virtual urgent care program.

"We were the first people in South Carolina to offer free virtual care COVID screenings," said O'Bryan. "I'm really proud that we were able to roll it out so quickly and that so many South Carolinians took advantage of it."

BMIC researchers developed an artificial intelligence algorithm that could analyze symptom data provided by patients during virtual urgent care screenings and prioritize those most likely to have COVID-19 for testing. The algorithm proved critical when testing capacity was challenged and should continue to play a key role with the implementation nationwide of "batch testing." Essentially, samples from patients thought to be at low risk of having COVID-19 could be tested in batches of five to extend testing capacity. If the test comes back negative, all five patients are presumed to have a negative result. The algorithm helps identify low-risk patients appropriate for such batch testing while reserving individual testing for higher-risk patients.

"What we were able to do is make a very functional system, which, on the outside, might seem simple — you fill out a questionnaire on a telehealth platform, it goes in and everything happens behind the scenes," said McElligott. "But all of that had to be protected for the patient and linked in with the medical record and the lab. We had to know what to do to get testing sites set up with tents and then use the platforms to guide people there. There's just a whole lot of stuff that had to happen to be able to do this: not one patient at a time, but thousands at a time. We couldn't have done it without the bioinformatics group stepping in and helping to connect all the dots and then bringing new ideas to the table about how to monitor patients."

Remote patient monitoring

In the second prong of the four-pronged approach, patients who tested positive were then invited to enroll in a remote patient monitoring (RPM) program. That program, which had been used to track data on patients with chronic disease, was transformed into a virtual means of monitoring and delivering acute care to patients with less severe COVID-19 who were recovering at home. RPM nurses contacted patients by telephone or text to ask if they wished to enroll in the program. Enrolled patients were asked to answer online survey questions daily about the symptoms they were experiencing and to provide temperature and oxygen saturation values. BMIC researchers created a "best practice alert," which notified a patient's RPM nurse should his or her condition begin to deteriorate. The nurse could then call the patient, alert the patient's primary care provider or arrange for a video consultation with a physician at MUSC Health. Patients who developed more severe disease could be hospitalized.

By the end of August, 735 patients had been treated through the RPM program. Of those patients, 20% were considered high risk and

32% medium risk. Some of these patients lived alone or in rural areas, and the daily contact and calls with RPM nurses were an emotional as well as medical lifeline.

"The lead nurse ends up being a connection to care for a pretty decent number of people who are otherwise fairly isolated," said Ford. "They may live in rural areas. They may be elderly and live alone. They're also supposed to be in quarantine, so they're not supposed to be out and about and have people around them. So it ends up being an important kind of emotional support tool for folks with cases of COVID-19 that are on home quarantine."

Telesitter program

The third prong of the approach, a telesitter program, is intended for patients hospitalized with more severe disease. An audiovisual cart, previously used to monitor patients to keep them from falling, was adapted so that caregivers could monitor and interact with patients with COVID-19 without having to don and doff personal protective gear each time, at the same time limiting the exposure of the health care worker.

"That's been a real satisfier for the clinical teams. They are able to have that kind of ease of communication without having to go into the patient's room each time," said Ford.

Reimagining outpatient care

In addition to ensuring a smooth continuum of care for patients with COVID-19, the team of telehealth and bioinformatics experts also wanted to provide a way for providers to continue to treat all of their patients, not just those with COVID-19. During the lockdown, most in-person outpatient visits were canceled, leaving many patients without needed medical care. Leaders at the Center for Telehealth quickly began the gargantuan task of preparing to transition most outpatient visits to telehealth visits.

"The scale of response was … it was something I never thought I'd see," said McElligott.

Article coauthor **Jillian Harvey, Ph.D.**, associate professor in the Department of Healthcare Leadership and Management at MUSC, agrees with this assessment.

"Telehealth has always been seen as the promising solution for access to the health care system, but its utilization hasn't picked up as quickly as we expected," explained Harvey. "Now, because of COVID, there has been a huge ramping up of telehealth across the country, especially in March, April and May."

During that timeframe, telehealth visits soared from less than 5% to more than 70% of all visits at MUSC Health. Between March and July, almost 30,000 outpatients met with their physicians via secure video teleconferencing. To make that happen so quickly, the Center for Telehealth, which previously had focused predominantly on providing services externally to patients in remote areas of the state, suddenly had to integrate itself more deeply into clinical practice at MUSC Health.

"We had to replicate the whole design of the health system in a microcosm," said McElligott.

Typically, he explained, the Center for Telehealth would have smoothed out work processes and flows for such an initiative, but due to the public health emergency, there was no time.

"We set up an organizational structure to try to get this done, changed video technologies to more user-friendly ones, built a bunch of tip sheets about how to do it, and we just rolled it out and let everybody innovate."

And innovate they did. Physicians in every specialty took those tip sheets and figured out for themselves how to overcome every obstacle so that they could begin seeing patients virtually.

"So the true heroes in all of this are the frontline providers who took the information and figured out how to do it themselves because they knew they had to or patients weren't going to be seen," said McElligott.

The way forward

Due to the pandemic, many more providers, payers and patients have become aware of what telehealth can offer. How deeply it will remain integrated into health systems will depend, in part, on whether payers continue to reimburse for telehealth visits at a rate similar to that for in-person care, as they are now doing.

"This ambulatory care conversion required an infrastructure rebuild but is probably the initiative with the most lasting impact," said King. "Now that providers and patients know what telehealth can do, I don't think they will ever give it up."

"There's no real going back to a lack of telehealth use," said McElligott. "That has probably been forever changed."

Indeed, McElligott believes that the pandemic has helped to transform how providers and the public view health care.

"Our health care system has always been very focused on a provider-centric view of health care. In other words, you as a patient come to the provider, and that's how we work," explained McElligott. "Just using distance technologies starts to reverse that. This terrible pandemic has forced a reckoning and a realization that, in terms of the long-term goals of improving health, it's really more important to meet the needs of patients where they're at."

Patient Perspective

A sit-down between a shoulder replacement patient and his surgeon

BY CELIA SPELL

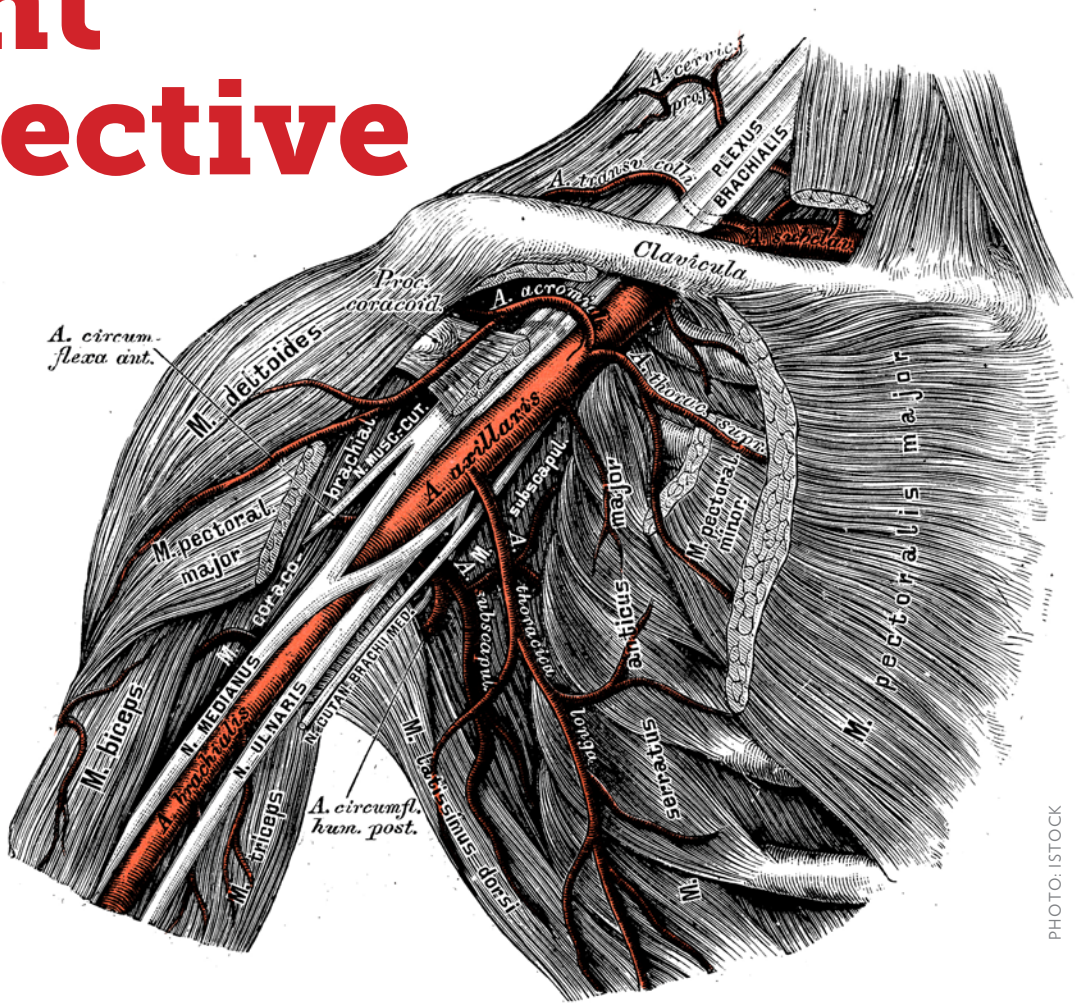


PHOTO: ISTOCK

Most health care providers pursue medicine to exercise compassion or empathy, but the speed of daily schedules and the number of daily patients can cloud that desire. Hearing from patients can serve as a reminder. In this article, we check in with Todd Fisher, a patient at MUSC Health, to learn more about the impact his health care providers had on him.

As a mechanical engineer in his 40s with an active lifestyle and a love for kayaking, Fisher knew his shoulder pain was holding him back. He had put off getting his first shoulder replacement on the right side for years because of fear, but the pain became unbearable. He came to MUSC Health to work with **Josef Eichinger, M.D.**, an orthopaedic surgeon and professor of orthopaedics at MUSC Health, whom Todd jokes is another kind of mechanical engineer. Eichinger focuses on shoulder and elbow surgery, and he is also interested in sports medicine for overhead throwing athletes.

After seeing the results of his first shoulder surgery, Fisher realized just how bad the left side had become. Once the pain on the right side no longer eclipsed it, the pain on his left was thrown into relief. But he wasn't nervous the second time around; he was ready. Eichinger sat down with Fisher to learn more about his experience with his reverse total shoulder replacement and his anatomic total shoulder replacement.

Eichinger: Thanks for sitting down with me today, Todd. Could you tell me a little bit about your two shoulders and your discomfort prior to surgery?

Fisher: My range of motion was so limited in both shoulders. Every day when I'd go to put on deodorant, I would be reminded how bad it was. I was in near constant pain, especially during any kind of motion or activity. The pain started in high school with a combination of genetic instability and martial arts, but in the years since it had only

gotten worse after my motorcycle accident.

Eichinger: On your right shoulder you have what is known as glenoid dysplasia, which basically means your socket didn't form normally, and it can range from mild to severe. Yours was severe enough that it was contributing to your pain. That's why we decided to go with a reverse total shoulder replacement. We flipped where the ball and socket are in your shoulder, which makes dislocation in the future much more difficult. What was it like leading up to that surgery?

Fisher: The surgery was a little scary upfront. I put it off for years because of that fear, but the pain just became worse, and I felt like I had nothing left to lose. I had such a small range of motion, and I was in constant pain. But this was the biggest surgery I had ever been through. I came into MUSC a week before the procedure to make sure I was healthy enough to undergo the procedure. Then the night before, they called me to let me know what time my surgery would be. I didn't eat anything that morning, met with my anesthesiologist and the rest of the surgical team. They took me back for what felt like a long nap, and then I woke up wearing a sling. And the next day they send you home. Definitely not a bad experience, and I was especially surprised by how quickly I was able to stop taking painkillers.

Eichinger: We always try to limit our patients' narcotic consumption, and we often explore other methods for treating pain. You were given a pump that provided localized general anesthesia to your shoulder, which helped curb any need for narcotic medication. So what about physical therapy? Could you tell me a little bit about that experience?

Fisher: Physical therapy was intense, but it was all muscular. The pain was gone, and I was left with weak muscles after not using them for so many years. It didn't hurt, but I was very sore. It was like going to see a personal trainer who only cared about three or four of your muscles. And I did that for about six months. I was back to performing normal tasks like showering, getting dressed and driving after about six weeks, but it took six months of physical therapy before I was able to go back to activities like kayaking.

Eichinger: Now let's talk about your left shoulder. How did it feel after your right shoulder replacement?

Fisher: The pain in my left shoulder had always been so minor compared to the right shoulder, but once I no longer felt that right-side pain, the left side started screaming at me. And I was no longer scared of the surgery since I had already experienced a successful one, so six or seven months after my other surgery, I was ready for the next one.

PHOTO: ANNE THOMPSON

Josef Eichinger, M.D., orthopaedic surgeon and professor of orthopaedics at MUSC Health

Eichinger: Since you're so young, we talked about alternatives to another shoulder replacement, but ultimately decided it was our best option after realizing you didn't have any cartilage between the ball and the socket of your left shoulder. It was just bone on bone with no space between, so we performed an anatomic total shoulder replacement. What was the recovery like for that procedure?

Fisher: Recovering from the left shoulder replacement was slightly easier than the right. Prior to surgery, I had decent range of motion. I had pain, but my muscles didn't need to be retrained like with the right side. After only about four months of physical therapy, I felt like myself again.

Eichinger: And what are your pain levels now that it has been a few years since these procedures?

Fisher: Every so often I'll feel a slight spasm of pain, but it's always temporary and never anything close to what it was before surgery. I'm almost pain-free, and I can do anything I want now. I'm only limited by activities that would shorten the lifespan of my replacements, like operating a jackhammer or impact sports. But being in my 40s means I shouldn't be doing those things anyway!

Eichinger: Technology is always changing, and these replacements have improved in recent years. Many patients will have 20 years before needing any part of it replaced, and others will go the rest of their lives without another replacement surgery. What would you think about needing another surgery?

Fisher: I would say it was still worth it. If after 20 years of having my freedom and independence back means I would need a relatively minor surgery to replace some of the equipment, it would be a success in my book.

Interview

MUSC Health welcomes David Zaas, CEO of the Charleston division

PHOTO: BRENNAN WESLEY

With a chuckle, **David Zaas, M.D., MBA**, describes himself as a disappointment to his family. Leaving Cleveland, Ohio, to play football for Yale and pursue an undergraduate degree, Zaas was the first of his family to say goodbye to their hometown. And now he's taking that leap a step further by moving to the Lowcountry to become the chief executive officer for the Charleston division of MUSC Health as well as the chief clinical officer for the entire health system.

To get to know our new CEO and CCO, we asked him a few questions.

What brought you to MUSC Health?

After spending 20 years with an organization like Duke University, you don't often think of leaving. But last fall I learned about a new leadership role at MUSC and was told by several peers to look into it. The reputation of MUSC is outstanding, with recognition for clinical care and a strong commitment to the community, and it's one of the top academic medical centers in the Southeast. When I came to visit during the interview process I was really impressed by the people and the organization. Everything everyone said about MUSC was true — people here really are committed to the academic mission, and they are committed to helping the community and the state of South Carolina. The sense of enthusiasm and teamwork was evident in everyone that I met during the search process. Although changing organizations is never easy, I just knew that MUSC was the perfect fit.

How did you discover you had a passion for medicine and wanted to pursue a career in it?

I knew at an early age that I wanted to be a doctor. In high school, I did research at the Cleveland Clinic, and I loved being surrounded by all of that science and

"Everything everyone said about MUSC was true — people here really are committed to the academic mission, and they are committed to helping the community and the state of South Carolina."
—David Zaas, M.D., MBA

innovation. And working on a research team showed me how much value there is in working together. That's what science is, working as a team to discover something that helps others. So, I left my hometown to complete my undergraduate degree at Yale. Next, I headed to Northwestern University for medical school, where I met my wife. We dated all through medical school, married just before graduation and then couples matched for residency at Johns Hopkins with fellowships at Duke.

What inspired you to be both a physician scientist and an administrator?
I originally thought my career path would be that of a more traditional physician-scientist. After I completed my training, I started my career as a transplant pulmonologist and a scientist interested in studying the molecular basis of infectious complications in transplant patients. But if you had asked me back in 2005 if I would have ever been a hospital administrator, I would have thought you were crazy.

A few years after my fellowship, I had an opportunity to lead Duke's lung transplant program. While I enjoyed my short research career, leading our lung transplant program showed me my real passion was in management and leadership. I loved leading a team, and our lung transplant program became the top lung transplant program in the country.

My experience leading our transplant program led to other leadership opportunities at Duke, in the School of Medicine and the faculty practice. While my clinical passion has always been in transplantation, I learned that I also really enjoy leading high-performing teams. In 2014, I transitioned from traditional physician leadership roles to become the President of Duke Raleigh Hospital and was able to lead the outstanding team there. Reflecting on almost 20 years at Duke, I have learned so much from incredible mentors in each of my different roles. While I wound up taking a different path than I had originally thought I would take, all my experiences will help me be the best leader I can be for MUSC Health.

How do your two roles of CEO and CCO fit together?
It is really exciting to come to a health system that is growing and is committed to improving the health of its state. As the chief executive officer for the Charleston division, I will be working with the College of Medicine as well as the faculty practice to lead our clinical services locally. As the chief clinical officer for the health system, I will be part of a group called Team SC (System Council) where we discuss how best to integrate our growing system and provide the right care to the right patients at each of our hospitals. As the CEO and CCO, I will be able to help bring the different components of MUSC Health together.

What are some things you like to do outside of work?
Having two teenage boys is the best part of being home, and we're a very active family. Prior to the pandemic, we loved to travel, experience different cultures and find great places to hike wherever we go. My kids are also huge soccer players and fans, so we enjoy traveling as a family around the U.S. and around the world for soccer. More recently, my wife and I have been doing our best to become amateur wine connoisseurs, and we've had a great time with that.

Lastly, what are you most looking forward to in your new role at MUSC Health?
I'm excited to learn as much as possible about MUSC — its history and its people. I'm really looking forward to getting to know all of the 10,000 outstanding team members in Charleston, as they are critical to our patients. I have already learned that MUSC is an amazing organization and I am excited to be part of it. I know that we are all committed to providing the highest quality care to our community, educating our future health care leaders and advancing research and innovation to improve health.

MUSC
Medical University of South Carolina

Changing What's Possible®

Nonprofit Org.
US Postage
PAID
Permit No. 254
Charleston, SC

171 Ashley Avenue
Charleston, SC 29425

Progressnotes Credits

Visit MUSChealth.org/pn for additional online content.

Visit MUSChealth.org/pn/Subscribe.

PROGRESSNOTES

MUSC'S MEDICAL MAGAZINE // FALL 2020