FALL 2021 CONTROLOGINATION School of Medicine and Frain Biomedical Research Institute at VTC

DISCOVERY CHANNELS

Partnerships in support of innovation are fostering better health care solutions.



SPECIAL REPORT

Discovery Channels

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BY TIFFANY HOLLAND and JARED LADIA



TOO OFTEN GOOD IDEAS are attributed to a stroke of brilliance. Sometimes it's the proverbial lightbulb going off that gets the credit. Rarely, though, is coming up with good ideas that simple.

Such was the complexity surrounding the inaugural Carilion Clinic IRONMAN 70.3 Virginia's Blue Ridge in June. The idea itself was born out of sheer endurance, a product of Carilion physicians Randy Clements' and T.K. Miller's experiences in IRONMAN events in Raleigh, North Carolina, and Kona, Hawaii, among other places, not to mention

Dr. Miller's role on the organization's global medical staff.

As with most brilliant ideas, to paraphrase Albert Einstein, it wasn't so much about finding the answer as it was asking the right question. In this case, "Why not Roanoke?" Why not Roanoke, indeed.

It took a tremendous amount of hard work to convince IRONMAN to come to our city, and hosting a world-class event like the IRONMAN was nearly as hard as participating in it. The federal government would have to close the legendary Blue Ridge Parkway. Our water authority would have to allow swimming in the city reservoir for the first time in history. If those obstacles weren't challenging enough, we would have to overcome a global health pandemic.

Yet, magically, the morning of June 6, it all came together. I arrived before dawn at the start of the first leg to "Welcome IRONMAN" signs, hundreds of bikes racked and ready for the second leg, and a throng of elite athletes, family members, and friends with music playing in the background. For the first time, IRONMAN—our IRONMAN—was real. Roanoke was the center of the universe for more than 1,500 triathletes from across the country.

I officially opened the race with words of welcome over a bullhorn, then fired the cannon, and the competitors—led by Dr. Clements—jumped into the water, marking the beginning of the hours-long test of the limits of human endurance.

The event was at once overwhelming and joyful, as I thought about how far we'd come from that seed of an idea years before and all the planning and coordination required to make that day happen. I felt elated—and not just because I personally believe in the value of physical fitness or because the event signaled our first hopeful emergence from the pandemic. It was also because I believe so strongly in our region and because our region believes in visionaries—those who aren't afraid to keeping asking, "Why not?"

The special report in this issue tracks the germination of great ideas, from a new method of repairing orthopaedic injuries to a portable system for diagnosing mild traumatic brain injuries, all in service to better patient care. Throughout these stories, you can see the commitment and vision of so many to bring strength to the region one leg—or one invention—at a time.

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Patrice M. Weiss, M.D. Chief Medical Officer and Executive Vice President **Carilion** Clinic

Carilion Medicine

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Carilion Medicine is published twice a year at: 213 McClanahan Street, Suite 200 Roanoke, VA 24014 Phone: 540-266-6586 Fax: 540-266-6608

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Carilion Clinic is a nationally ranked integrated health system headquartered in Roanoke, Virginia. Its flagship, Carilion Roanoke Memorial Hospital, is the clinical affiliate of the Virginia Tech Carilion School of Medicine and Radford University Carilion.

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On the pulse of the Carilion Clinic community

High Flyer

A new, 240-foot-tall tower crane on the Carilion Roanoke Memorial Hospital campus joined the Roanoke skyline in June.

The crane now stands as the second-tallest structure in the immediate area, surpassed only by the 320-foot-tall Wells Fargo building, the tallest structure in southwestern Virginia.

The crane, which can lift up to 22,000 pounds, will support construction activities taking place over the next two years on Carilion's new Crystal Spring Tower. When it's completed in 2025, the tower will span 500,000 square feet across 10 stories, offering 64 new patient rooms, a 550-space parking garage, and a relocated and expanded Emergency Department.



HEAVY LIFTER: The 240-foot crane, which can lift up to 22,000 pounds, will support construction of Carilion Clinic's new 10-story Crystal Spring Tower over the next two years.



a Noah's Ark mural, and a semicircular check-in desk to accommodate multiple patients at once.

TAKING CENTER STAGE

The Carilion Children's Tanglewood Center opened in early October. The building, housed in the space formerly occupied by JCPenney in Roanoke County's Tanglewood Mall, is now home to Carilion Children's outpatient specialty practices. "For several years, Carilion Children's has expanded specialized pediatric services for our community, and we're excited to finally have a new home for our specialties all under one roof," said Donald Kees, M.D., interim chair of Pediatrics. "This facility will be a destination for expert pediatric care for families in our region and beyond."

In brief

The center has been designed as a onestop shop for patients, many of whom see more than one specialist. The two-story, 77,000-square-foot facility houses 120 exam rooms, multiple consult rooms, and imaging and laboratory services. Patients can access 13 pediatric subspecialties, including physical, occupational, and speech therapies and an ENT/audiology and dentistry service for both children and adults.

"In all this excitement, the goal remains the same," said Dr. Kees. "We're here to provide specialized care, close to home, for the children in our region." 🔐

Code Lavender to Support Frontline Caregivers

A Carilion Clinic team was recognized as one of only 16 nationwide to receive a Henry Luce Foundation microgrant through the Chaplaincy Innovation Lab at Brandeis University. The goal of the microgrant is to provide resources for chaplains researching and supporting frontline staff well-being and resiliency.

"We are thrilled with this support," said Rev. Andrew Tressler, a co-leader of the interdisciplinary team and Carilion's director of chaplaincy. "The microgrant will help us build on our staff-support offerings, which are more critical than ever as caregivers continue to work through the pandemic."

Carilion's program—called Code Lavender-will provide emotional and spiritual support to frontline caregivers through rapid response during crises. When any caregiver experiences a crisis, a Code Lavender will be called via direct page to a chaplain. (Carilion Roanoke Memorial Hospital has an in-house staff chaplain 24/7.)

"No event is too small to call a Code Lavender," said Tressler. "If an employee needs support, they're encouraged to call."





ON THE JOB: Already

leading-edge research

richly equipped with

instrumentation and

laboratories for up to

the building has been

operational for a year.

25 research teams,

MAJOR MILESTONE

ith the approval of more than 200 spectators, representatives from Virginia Tech, Carilion Clinic, Roanoke, and the Commonwealth of Virginia ceremonially opened the Fralin Biomedical Research Institute at VTC Addition in early October.

The \$90-million, 139,000-square-foot expansion will enable the institute to double its workforce by 2027. With wet laboratories, meeting spaces, and offices to accommodate 400 additional researchers, students, and support staff, the addition is also home to Virginia Tech's Molecular Diag-

nostics Lab and the Virginia-Maryland College of Veterinary Medicine Animal Cancer Care and Research Center.

During the ceremony, Virginia Tech's president, Tim Sands, Ph.D., underscored the

importance of biomedical research, especially in the wake of a global pandemic. "As the past several months have demonstrated," he said, "the nexus of health, science, and technology is the place where humanity confronts the Agee, president and chief executive officer of challenges of the future."

Michael Friedlander, Ph.D., Virginia Tech's vice president for health sciences and technology and the institute's founding executive director, emphasized the powerful public-

private partnerships that have led to the institute's rapid growth and success.

"This effort demonstrates the commitment of the Commonwealth of Virginia, Virginia Tech, and Carilion Clinic to discovery in the service of health," Dr. Friedlander said. "I am certain that even beyond the timeframe of the careers and lives of those of us who have the privilege of serving in this enterprise today, what you have all built here will continue to provide life-changing discoveries in the service of health and a catalyst for the economic vi-

tality of this region for decades to come."

After several years of construction, the grand opening punctuated the success of the Virginia Tech Carilion partnership, following a \$45 million appropriation by the Virginia General

Assembly to support the new development. Noting the transformation of the region's

economy and Roanoke's growing position as a hub for the biosciences, Nancy Howell Carilion, said, "One of my favorite proverbs describes 'collaboration' well: 'If you want to go fast, go alone. If you want to go far, go together.' Well, we've gone far and fast. Just look at what we've accomplished." 🚔

EXPANDED FOCUS ON DIVERSITY. EQUITY. AND INCLUSION

athaniel L. Bishop, D.Min., has "In so many ways, he has been doing this been named leader of Carilion Clinic's new Office of Diversity, Equity, courage, commitment, and compassion and Inclusion.

As the health system's first chief diversity, equity, and inclusion officer, again over the years."

Dr. Bishop will work to expand Carilion's efforts to advance community and public health, in keeping with its mission.

"NL's cultural competence and his approach to honoring each individual's unique abilities and contributions make him the perfect person to take on this dynamic new

role," said Nancy Howell Agee, president and chief executive officer of Carilion.

Dr. Bishop served as president of Carilion's Jefferson College of Health Sciences from 2010 until its integration with Radford University in 2019. He was then named senior vice president of administration at Carilion and senior associate dean for diversity, inclusion, and student vitality at the Virginia Tech Carilion School of Medicine.

healthy competition

IRONMAN Shows Great Strength

The inaugural Carilion Clinic IRONMAN 70.3 took place in Roanoke in early June, with more than 1,700 athletes from 45 states participating. Those intrepid souls embarked on a 1.2-mile swim in Carvins Cove, a 56-mile bike course along the iconic Blue Ridge Parkway, and a 13.1-mile run on the Roanoke River Greenway. More than 265 volunteers and 150 medical staff from Carilion were stationed throughout the course. The event produced an estimated \$3.8 million impact on the region.

"The selection of Virginia's Blue Ridge region as an IRONMAN host was a remarkable honor for everyone who calls our region home," said Thomas "T.K." Miller, M.D., vice chair of Orthopaedics, chief of Sports Medicine, and chairman of the IRON-MAN Global Medical Advisory Board. "It was a wonderful opportunity to share our resilience with the competitors, volunteers, and spectators. The triathlon was evidence of our community's strength in coming together to overcome adversity and showcase the region's outdoors and our collaborative spirit."



work for decades. He'll bring the same to diversity, equity, and inclusion initiatives that he has brought time and time

> Patrice M. Weiss, M.D., Carilion's chief medical officer and executive vice president, agreed. "Our sponsorship of this event was such a natural fit," she said. "IRONMAN's focus on fitness and improving health around the globe aligns with our mission to promote wellness and active lifestyles and improve health across Virginia."

Transformative Partnership



Carilion Clinic was one of just three health systems chosen nationally to partner with

ReThink Health, a Rippel Foundation initiative aimed at broadening the role of hospital systems within their regions. As part of the ReThink Health view of hospitals as stewards for the health of entire populations, Carilion will explore transformative roles for hospital systems regionally as well as fresh approaches to community collaborations.

Excellence Designation for Nursing



Carilion New River Valley Medical Center (CNRV) has received the American Nursing **Credentialing Center**

Pathway to Excellence designation. CNRV is the first Carilion hospital to earn this honor and only the eighth across the state. Just 195 hospitals nationwide hold this four-year designation, which recognizes programs that foster a positive practice environment for nursing staff.

The designation process focused on 63 elements of nursing performance and six standards considered essential to developing a positive practice environment for nursing staff. Those standards—shared decision-making, leadership, safety, guality, well-being, and professional development—are known to affect a range of factors, such as turnover, job satisfaction, productivity, patient safety, and teamwork.

"Our culture of caring allows us to achieve at the very highest levels in the areas that matter most—patient safety and clinical outcomes," said Bill Flattery, vice president of Carilion Clinic's Western Region. "Our nursing staff is critical to everything our hospital achieves."



THE HEALING BRIDGE

he canvas may have been a pedestrian bridge, but the art was anything but pedestrian. In June, as part of the Dr. Robert L.A. Keeley Healing Arts Program, Carilion employees painted a mural on the pedestrian bridge leading to Carilion Roanoke Memorial Hospital. "This mural is part of the Healers' Circle

Project, an initiative designed to connect Carilion employees and our community with a shared intention of healing both within ourselves and with each other," said Katie Biddle, Ph.D., Healing Arts program consultant. "The artists painted a series of mandalas, which are works of art created with a circle theme for the purpose of restoration and healing."

crisis management

Mental Health Navigation Line



In response to the multi-layered crises of the COVID-19 pandemic, the economic downturn, and racial injustice, Carilion Clinic Community Health and Outreach and Carilion's Department of Psychiatry and Behavioral Health have partnered with local organizations to develop a mental health network for the City of Roanoke.

The free and confidential Mental Health Navigation Line now connects Roanoke City residents with

mental health support, substance use treatment, and other community resources.

"We are very excited to be working together as a community to expand access and build capacity for mental health and substance use treatment services," said Shirley Holland, vice president of planning and community development at Carilion. "Ultimately, this will allow us to better understand the needs of our community and determine gaps where we can work together to develop future resources and programming."

Largest Depression Clinical Trial in History

Carilion Clinic is now participating in RECOVER, a national clinical trial that may make vagus nerve stimulation (VNS) treatment more widely available for patients with difficult-to-treat depression. The trial is the largest depression study in history.

Carilion's participation is a collaboration between the Department of Psychiatry and Behavioral Medicine and the Department of Neurosurgery. Anita Kablinger, M.D., director of clinical trials research in the Department of Psychiatry and Behavioral Medicine, will follow participants throughout the study.

Dr. Kablinger notes that VNS is sometimes referred to as a pacemaker for the brain, and the benefits of the device are measured in years, not weeks.

Carilion is one of 100 medical centers in the country—and the only health system in Virginia—participating in the trial. Neurosurgeon Mark Witcher, M.D., PhD., recently implanted the first VNS device.

"Participating in the RECOVER clinical trial is an exciting opportunity for patients suffering with difficult-to-treat depression," he said. "From a neurosurgery standpoint, it's a relatively minimally invasive procedure that can make all the difference for patients. Hopefully, the results of this trial will lead to broader availability of VNS treatments for people with depression."



TEAM RECOVER: Carilion is participating in a national clinical trial that may make vagus nerve stimulation treatment more available to patients with intractable depression.



FIRST STEPS: Dr. Biraj M. Patel, the first physician in the country to enroll a patient in a balloon-guided catheter trial for use in stroke-patient surgery, is also national principal investigator for the trial.

Balloon Trial

n July, Biraj M. Patel, M.D., a neurointerventional radiologist at Carilion Clinic, became the first physician in the country to enroll a patient in the FAST-BGC clinical trial for balloon-guided catheter use in stroke patients.

Traditional catheter technology used to treat stroke patients resembles a small tube through which another smaller catheter and sometimes a stent-like device are used to retrieve the clot. The catheter is inserted through a blood vessel and the device is used to remove the clot from the brain before it has time to cause significant damage. The balloon-guided catheter works in conjunction with traditional

technology. The catheter uses a small balloon to temporarily stop blood flow in the neck, which allows for easier and more effective access to and extraction of the clot in the brain. While the blood flow is temporarily stopped, the physician uses a second catheter to remove the clot. After removal, blood flow is returned to normal. "This research is assessing technical efficacy and safety associated with the new balloon-guided catheter used to treat stroke," said Dr. Patel, who is the national principal investigator for the clinical trial. One of only seven centers nationally participating in the trial, Carilion currently has the highest patient enrollment. 🎬

technology advances

Improving Imaging to Identify Cancer

In collaboration with Jefferson Surgical Clinic and Urology Associates, Carilion Clinic is now offering a more advanced technique for diagnosing prostate cancer.

The method—MRI/US Fusion—brings together the power of MRI and ultrasound technologies for a more reliable biopsy. In the past, men with elevated PSA levels were often sent for multiple random biopsies of prostate tissue. With MRI/US Fusion, an MRI exam maps potentially cancerous areas that are invisible to ultrasound. An ultrasound probe guided by a semi-robotic arm then targets any location identified as suspicious. "The ability to target the most concerning parts of the prostate gland using MRI is critical for appropriately staging prostate cancer and providing the most appropriate treatments," said Daniel R. Karolyi, M.D., Ph.D., chair of Radiology at Carilion.

PHOTO: KAREN MCNEW MCGUIRE

briefings

Top Regional Hospital



U.S. News & World Report has once again honored **Carilion Roanoke** Memorial Hospital

as a Top Regional Hospital. The hospital was noted especially for high performance in 13 procedures and conditions: aortic valve surgery, chronic obstructive pulmonary disease, colon cancer surgery, diabetes, heart attack, heart bypass surgery, heart failure, hip replacement, kidney failure, knee replacement, lung cancer surgery, stroke, and transcatheter aortic valve replacement. Overall, the hospital tied for 6th best hospital in Virginia.

Luminary Leader



Modern Healthcare has named Nancy Howell Agee, Carilion Clinic's

president and chief executive officer, one of 2021's Women Leaders Luminaries, a list that recognizes executives whose careers have been defined by reshaping the industry.

Agee is a nationally recognized health care leader and past chair of the American Hospital Association. She was first named to Modern Healthcare's biennial list of Top 25 Women Leaders in 2017 and is perennially among its 100 Most Influential People in Healthcare.

"Nancy's superb leadership continues to earn national recognition and bring honor to our entire organization," said **Carilion Board Chair James** Hartley. "We are so proud of her."

grand rounds

Pedagogical Pioneer



Oscar Alcoreza, the first student to enter the M.D./Ph.D. program at the Virginia Tech Carilion School

of Medicine, successfully defended his doctoral dissertation on innovations in treating seizure disorders. He is now undertaking clinical rotations as a third-year medical student.

Training Infusion

Following a competitive grant process, the Virginia Department of Medical Assistance Services awarded Carilion \$2.4 million to support 18 internal medicine residents and six psychiatry residents.

Two Generations Learn Together



Master's students in occupational therapy at Radford University Carilion offered summer camps aimed at helping children build their cognitive, motor, sensory, and social skills. The camps also allowed the master's students to learn how they can help pediatric clients improve their skills to increase their confidence, participation, and independence in life.

"These camps were our first opportunity to take the information we have learned in our academic curriculum and apply it in a real-life setting working with children," said master's student Kelsey Kokkonen.

THE PLACE TO BE: Many alumni



THIS IS HOME

The first 42 students to enter the Virginia Tech Carilion School of Medicine sat together in orientation just over a decade ago, their excitement laced with just a bit of anxiety.

"The mayor welcomed us and talked about how the medical school was the biggest thing to happen to Roanoke since the railroad decided to build the depot there in the 1800s," charter class member Andrew Moore, M.D., said. "We were all looking at each other like, what? This guy is crazy. Then you look at what Roanoke has become a decade later, and he wasn't wrong."

After graduating in 2014, Dr. Moore, like most of his classmates, left Roanoke for residency training across the country. He went to Chicago for a residency in emergency medicine at Northwestern University and then to Portland, Oregon, for a research fellowship at Oregon Health & Science University. This summer, he and his wife and son packed up and moved back to Roanoke, where he is now an emergency

medicine physician at Carilion Clinic and an assistant professor at the medical school.

"I know one of the hopes for the school was that medical students would stay or come back, but national data show people tend to practice where you do residency or where your mother-in-law lives," Dr. Moore said, laughing. "There must be something in the water for VTC to bring back a sixth of the charter class."

Twenty percent of Virginia Tech Carilion School of Medicine alumni have chosen Virginia for residency, fellowship, or practice. Just over 8 percent of them are now based in Roanoke.

"We always knew our region is a great place to live, work, and play," said Nancy Howell Agee, president and chief executive officer of Carilion. "And we believed a medical school would further enrich our amazing health care. We are pleased to have our alumni return knowing they are joining an extraordinary team. We welcome them back with open arms."

Education at Carilion Clinic and its affiliates

NEW LEADER OF HEALTH SYSTEMS AND IMPLEMENTATION SCIENCE

Sarah Henrickson Parker, Ph.D., director of human factors research and senior director of the Center for Simulation, Research and Patient Safety at Carilion Clinic, has been named chair of the Department of Health Systems and Implementation Science at the Virginia Tech Carilion School of Medicine.

"Dr. Parker will bring new energy and ideas through her role as chair, particularly given her expertise in human factors and health care," said Lee Learman, M.D., Ph.D., dean of the school. "In addition to supporting the continued expansion of health systems science into the curriculum, she will build the department's research portfolio in health care innovation and implementation science."

Dr. Parker, who is also a research associate professor at the Fralin Biomedical Research Institute at VTC, centers her work on the study of human factors in health care delivery, working closely with clinicians to improve patient safety and quality of care.

"Research on implementation is the backbone of health systems science, with the goal of figuring out better ways to build a system where patient safety and quality of care are maximized," Dr. Parker said. "I am excited about taking the health systems science perspective and using it to enhance the department, education, and research opportunities for students at Virginia Tech and specifically within the medical school."



PHOTOS: RYAN ANDERSON (ABOVE AND TOP RIGHT): JARED LADIA (BOTTOM RIGHT



Celebrating Match Day Pandemic Style

Members of the Virginia Tech Carilion School of Medicine's Class of 2021 were able to celebrate their Match Day together and meaningfully, even as public health guidelines limited attendance.

"The Class of 2021 has shown tremendous adaptability, particularly when the pandemic postponed completion of critically important thirdyear clinical clerkships and severely restricted the availability of external clinical electives," said Lee Learman, M.D., Ph.D., the school's dean. "The class has been flexible and forward-thinking throughout these historic challenges, and it has paid off with some remarkable Match Day results."

The graduates have gone on to residency programs representing 18 specialties in 18 states, across 31 different academic health centers.

New Leadership



Arthur Ollendorff, M.D., has joined Carilion Clinic as the designated institutional officer, overseeing the Graduate Medical Education program and the residency and fellowship

directors. Dr. Ollendorff most recently worked in perinatal substance use disorders at Mission Health in Asheville, North Carolina. He also directed medical education at the Mountain Area Health Education Center and was a clinical professor of obstetrics and gynecology at the University of North Carolina-Chapel Hill. He is president-elect of the Association of Professors of Gynecology and Obstetrics.





onsider this one measurement: The Fralin Biomedical Research Institute at VTC had more than \$31.5 million in research spending in 2019.

To put that figure in context, it is more than the research spending of all Roanoke's 15 peer cities combined.

Then consider this: None of the infrastructure existed just a dozen years ago. "That's considerable growth in biomedical research and development expenditures within a decade," says Amy Holloway, director of Ernst & Young's Economic Development Advisory Services. "If health care remains a target of economic development, and collaborations among Carilion Clinic, Virginia Tech, and others continue, we would expect that investment to increase and economic development-whether it's entrepreneurial startups or the attraction of new businesses—to expand as well."

Holloway worked with the Roanoke Regional Partnership, the area's economic development marketing arm, to develop its current strategic plan. In the broader region that encompasses Virginia Tech's home base of Blacksburg, nearly \$542 million was spent in 2019 on university research and development. Those 15 benchmark regions that include places such as Savannah, Georgia; Asheville, North Carolina; and Erie, Pennsylvania? According to the National Science Foundation Higher Education Research and Development Survey, their cumulative spending totals \$29.2 million.

The figures do not yet capture the return on investments that both Carilion and Virginia Tech are making to bring more researchers, innovators, and entrepreneurs into an innovation corridor that is springing to life in a former railroad town that, until a few years ago, lacked a large state university presence within its borders.

"In terms of the lifespan of these industries and other regions, it's sometimes decades before they reach maturity," Holloway says. "For the Roanoke region, it's early still, so the job numbers are not high yet, but the innovation assets—which is the starting point—show this region is off to a good start."

Amid this success, Nancy Howell Agee, Carilion's president and chief executive officer, feels the urge to accelerate. "Innovation is academic, it's clinical, it's all mixed together, and that creates real excitement for people," she says. "The more you do, the more people want to be part of it."

That wasn't always the case. Carilion met much resistance when it began its transition from a collection of hospitals and primary care practices into an



integrated delivery network that would offer highly specialized care.

"I would say now, more than a decade later, we're being pushed to go faster and harder," Agee says. "A dozen years ago, though, it was, what the heck are you doing?"

Vision and Leadership

Some of that earlier skepticism centered on Carilion's attempt to seed a biomedical institute near its flagship Roanoke Memorial Hospital. The institute, it was hoped, would help develop and commercialize medical products.

"While that effort didn't work out as planned, it started people thinking about the notion that Virginia Tech and Carilion, the largest employers in the western half of the state, have a mutual interest in health care," says Ray Smoot, who was at the time chief executive officer of the university's foundation and a Carilion Clinic board member.

"I was in the position—as a senior administrator at Virginia Tech and a Carilion director—of having oars on both sides of the boat," says Smoot, who is regional chair for Growth and Opportunity for Virginia, better known as GO Virginia, a statewide economic development grant program that encourages regional collaboration. "That strategic vantage point gave me an understanding of how both organizations were looking at this opportunity and a perspective that allowed me to serve in a translator role."

Virginia Tech needed a medical center to realize its vision of becoming a top-ranked research university, and Carilion needed an academic partner to realize its vision of integrated care delivery.

Charles Steger, Ph.D., then president of Virginia Tech, and Ed Murphy, M.D., then chief executive officer of Carilion, forged a public-private partnership to build both a medical school and a research institute in Roanoke.

"Their leadership was critical," says John Dooley, who earlier this year retired as chief executive officer of the Virginia Tech Foundation. "Leadership also came from the state, which has been generous with appropriations, and local governments, which helped support the vision."

Roanoke spent about \$30 million to purchase the brownfields on which the Virginia Tech Carilion Health Sciences and Technology

Campus was built. The state provided bricks-and-mortar funds.

Dooley also credits Virginia Tech and Carilion leaders with making excellent hires to run both the medical school and the research institute.

"Boy, they outdid themselves by recruiting top talent before there was even much of a product to sell." Doolev savs. "And since then, those talented leaders have been so effective in encouraging others to embrace the vision."

One of those leaders, Michael Friedlander, Ph.D., founding executive director of the Fralin Biomedical Research Institute, believes successful, sophisticated scientists and entrepreneurs want to be part of a vibrant environment.

"That environment wasn't here at the time," he says. "We had to build a base that wasn't about hype. Now we have a solid, outstanding biomedical research enterprise populated with people who have earned—or are in the process of earning—national and even international reputations in their fields. You don't need a sales pitch and hype. What we've built speaks for itself."

Dr. Friedlander credits the university and Carilion for standing up both a biomedical research institute focused on excelling in several key areas and a medical school with a major emphasis on student engagement in meaningful research with institute scientists and Carilion clinicians. The institute has grown to more than 400 faculty, staff, and students, with dozens of research teams and an extramural grant portfolio currently valued at over \$140 million. Those teams have already spun out five biotechnology startup companies, winning multiple federal small business and technology transfer grants.

The partners also invested heavily in the venture while other funders, including the National Institutes of Health, had pulled back support during the Great Recession. The research institute has since doubled its size, and Virginia Tech has invested in building out its health sciences programs in Roanoke.



-Michael Friedlander, Ph.D., Executive Director, Fralin Biomedical Research Institute at VTC

Innovation within Carilion

"We had to build a base that wasn't about hype. Now we have a solid, outstanding biomedical research enterprise. You don't need a sales pitch and hype. What we've built speaks for itself."

> Carilion Chief Financial Officer Don Halliwill thinks the ability to start from scratch helped fuel success. "At academic health centers with decades if not centuries of tradition, it's hard to effect change," he says. "Our relative youth has allowed us to be nimble, and it's one reason I say with confidence, and not over confidence, that the best is yet to come."

> While Virginia Tech was building the research side, Carilion recruited more than 700 physicians, including specialists and subspecialists, who were attracted to the opportunity to create an academic medical center. The health system expanded its footprint, enlarging Carilion's Roanoke campus by creating institutes devoted to cardiovascular care and to orthopaedics and neurosciences, and by developing a standalone outpatient pediatric center.

> Yet something was missing for serial entrepreneur Victor Iannello, Sc.D. As a Carilion Clinic board member, he sat in on interviews to help recruit department chairs.

> "We were hiring many high-level people from organizations with robust research and innovation programs," Dr. Iannello says. "They expressed the desire



"Our relative youth has allowed us to be nimble, and it's one reason I say with confidence, and not over confidence, that the best is yet

to come. — Don Halliwill, Chief Financial Officer, Carilion Clinic

for those kinds of opportunities here. One reason I was talking to them was because, as an entrepreneur, I was also excited about innovation."

Dr. Iannello looked at research dollars and the number of patents filed, and saw opportunity. "There was so much more potential here than was being realized." he savs.

After rotating off the Carilion Clinic board, Dr. Iannello submitted a proposal to develop an in-house innovation program.

"I proposed a framework for funding proof-of-concept ideas and moving them through a funnel to license technology, spin out a company, or partner with a company with the expectation that somewhere along the line it would return some financial benefit to Carilion," he says. "This program would also serve as a way of keeping physicians engaged. These are intelligent, creative people for whom innovation provides another avenue to express themselves."

Dr. Iannello identified Troy Keyser to lead Carilion Clinic Innovation, which launched in 2020 and has since evaluated more than 80 ideas, with 50 now in various developmental stages. The team invests up to \$50,000 of milestone-based funding to ready an invention for the next stage of commercialization.

Carilion Clinic Innovation has invested in three startups, including Chorda Pharma, a company Dr. Iannello is now leading that focuses on developing opioid-free pain relievers. Projects developed by Carilion staff can also be considered for funding through Carilion and Virginia Tech's early-stage venture capital fund.

"About six years ago, we made a major commitment with the foundation on behalf of the university and then Carilion to launch what is now known as VTC Ventures," Dooley says. "The compelling argument is that we could nurture the innovation environment, but if we're going to be serious about starting up companies, and spinning out the ideas from the research institute and Carilion,

we're going to have to provide some level of funding infrastructure."

The funds offer up to \$500,000 for technologies and companies in the riskiest early stages, and up to \$5 million for projects further along on the commercialization path.

"It's not as though there was a moment when we said, 'We'll do more innovation," Agee says. "It was this yearning, the sense that we needed to get in front of whatever's new, whatever's next, and be a part of that. It's been evolutionary."

Agee says while health care providers are by nature curious and quick to identify problems and solutions, the medical field as a whole is slow to adopt change. She thinks the collaborative, quick global response around COVID-19 may serve as a catalyst.

Within Carilion, the pandemic led to innovative solutions to unique problems the highly contagious virus posed, including an intubation hood and fogless face shields for Life-Guard flight crew helmets.

Agee says she's also seen the benefits of the Center for Simulation, Research and Patient Safety, where human factors experts devise solutions, perfect designs, and test prototypes.

"We take on tools our care teams use every day and work with them to find ways to improve those tools," she says. "The classic example is our work with a defibrillator manufacturer whose device was recalled because of its potential to fail in critical situations. Our team discovered that the problem was something so simple as having the same button for 'on' and 'off.' Hitting the button twice could present catastrophic consequences.

"It's incredible to be able to influence changes that benefit the entire field," Agee adds. "Innovations that make things better for patients and caregivers are very exciting."

What's Needed Now

"We're not done with what we can accomplish here," Smoot says. "The next big matter to resolve is to what extent Carilion wishes to further evolve as an academic medical center. Carilion's primary role is providing quality care, but I think we're going to see much more research going on across the system."

Smoot says Carilion's continued evolution is necessary if Virginia Tech is going to reach its full potential. "Now, that's easier said than done," he says. "The first thing that comes to

mind is, who will pay for these positions, such as clinicians and technicians, who are engaged in research and not generating billable hours?"

Dr. Friedlander, too, is eager for Carilion to move deeper into research, finding better ways to share patient data and hiring physician scientists who both care for patients and spend time on research.

As Carilion progresses to this next level, Agee says, "We'll look for other ways to bring in revenue, potentially through philanthropy, and we'll work with our colleagues at the state and federal levels to find additional funding for research and innovation."

Dr. Friedlander says it's a long-term investment. "If you're looking at your bottom line, it's going to enhance your brand and your reputation, which in health care translates into referrals," he says. "But that's going to take at least 10 years, maybe even 20. And what does that do for the community in terms of health? It brings researchers and physicians together, so cutting-edge research is happening here. It gives your patients access to advancements now."

Halliwill views it similarly.

"The way we spend our patients' money is visible in the care we provide every day, whether emergency care, surgery, or delivering a baby," he says. "But we also allocate some money toward care that will benefit patients in the future through our work in innovation. I think of this investment as a long play. We've already accomplished so much. Just imagine what it will be like 10 or 15 years from now."

Beyond the Campus

In 2019, Carilion asked the University of Virginia's Weldon Cooper Center for Public Service to measure its impact on the local economy. The center found that Carilion had contributed \$3.2 billion to the state's economy the previous year, and accounted for about 10 percent of the Roanoke region's \$17 billion gross domestic product.

The center also projected that, within a few years, the research institute will have a \$465 million annual impact on the economy.

"All the nation's cities that have developed world-class research institutes in health have benefited in an exponential way," says Elizabeth McClanahan, who succeeded Dooley as chief executive officer of the Virginia Tech Foundation.

PHOTO: DEAN DIXON



"It's incredible to be able to influence changes that benefit the entire field. Innovations that make things better for patients and caregivers are very exciting."

For its part, the City of Roanoke has designated a stretch of real estate as an innovation corridor, launched a digital platform to support collaboration among existing and prospective entrepreneurs and businesses, and supported the creation of RAMP, a business accelerator to mentor startups. The city manager meets regularly with Carilion and Virginia Tech leaders to explore what more they can do jointly. In addition, the region's governments are working together to address transportation and housing needs to support the growth.

"I believe the most significant changes of this century will occur at the intersection of health and technology," Agee says. "Carilion and our region are well positioned to benefit from the many innovations that will ease the burden on providers, improve the quality of care they deliver, enhance access to care for patients, and ultimately lower the cost of care. The health care field is ripe for innovation, and I'm proud we're helping to lead the way."



-Nancy Howell Agee, President and Chief Executive Officer, Carilion Clinic



roy Keyser is looking for the next good idea to help clinicians better care for their patients not just at Carilion Clinic, but nationally and even internationally.

Keyser leads Carilion Clinic Innovation, a partner for Carilion's innovative staff that works to propel their ideas and inventions for improving care to the larger marketplace through commercialization. Innovations can be brought to market by an industry partner or spun out as a startup so patients across the country and globe can benefit from employees' curiosity and commitment to innovation.

Carilion employees have shared more than 80 ideas, or "invention disclosures," since the program launched in 2020. More than 40 invention development projects have been funded and managed, a dozen patents have been filed, three startups have received investments, and several commercialization agreements have been executed.

Inventions that are in the active pipeline include an improved orthopaedic procedure with accompanying novel devices, an artificial-intelligence-decision-support module for cardiac PET, and a personalized sensoring device for pulmonary patients.

"I always try to reflect on Carilion's original vision and goals," Keyser says. "How can we improve the health of our community through innovation? How do we build a thriving innovation ecosystem within Carilion? And how can we strengthen our region's role as an economic engine for health care innovation?"

Carilion Clinic Innovation

Keyser was working in Boston, one of the country's centers of health innovation, putting together clinical trials, licensing, and collaboration deals for Harvard-affiliated hospitals, when he learned of the opportunity in Roanoke. He jumped at the chance to build a new department focused on commercializing Carilion innovations and growing the region's health and life science startup ecosystem.

"First and foremost, the area has an authentic collaborative spirit," Keyser says. "That's what really struck me. This is a very intentional community at a large scale, a community that understands the power of coming together."

Keyser soon connected with serial entrepreneur Victor Iannello, Sc.D., who was setting up Carilion Clinic Innovation to encourage employees to develop and commercialize inventions to improve health care.

When Keyser first joined Carilion, the majority of inventions were concepts or rough sketches, and it became clear that greater resources would be needed to move the inventions through the development lifecycle. He has since recruited a biomedical engineer, Prachi Joshi, to lead Carilion Clinic Innovation's invention development arm, and molecular bioscientist Aileen Helsel, Ph.D., to lead the commercialization arm.

Keyser says each idea is scored to determine whether it is novel, rather than just a tweak to existing devices, and whether it has commercial potential. Qualifying inventions can receive up to \$50,000 in funding, along with project management resources guided by agile and lean methodologies. Carilion owns the intellectual property generated by employees, and then reinvests any proceeds as part of a virtuous cycle. Carilion handles the patents, develops the ideas, and markets the products. If an invention is successfully commercialized, the inventor receives at least 40 percent of the revenue generated.

"Our focus is on innovations with commercial potential," Keyser says. "Not only might our patients benefit, but if we were able to license that intellectual property to, say, a medical device company that could bring the innovation to a larger market, patients across the country, if not the globe, could benefit. To get to that endpoint, we needed to make sure we had the right infrastructure to assess employee inventions to understand the commercial potential."

The Human Factor

Beyond Carilion Clinic Innovation, Carilion's innovators have a dedicated latticework of resources and funding opportunities. Close to home is Carilion's Center for Simulation, Research and Patient Safety, which houses the Carilion Clinic Innovation makerspace, complete with high-performance 3D printers for rapid prototyping.

Sarah Henrickson Parker, Ph.D., senior director of the center, works to translate evidence into practice. As chair of health systems and implementation science at the Virginia Tech Carilion School of Medicine, she seeks to support inventions through the end use.

"This is ground-up economic development, where you are taking many acorns and nurturing them, hoping a few turn into some pretty tall oaks."

-Greg Feldmann, Executive Director and Chief Executive Officer, Verge



THE KEY PLAYERS



Clinic Innovation

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tional community at a

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collaborative spirit.



Troy Keyser Director of Carilion

"When someone develops a new tech-

nology or drug, there's a lot of excitement

around the potential," she says. "And when it

receives FDA approval, that's the pinnacle of

promise. But then when it comes to actually

implementing the innovation, to getting it

cines. Those working to make the vaccine

were not the same people designing the sy-

ringe, figuring out how to transport the vaccine, or mounting a public health campaign.

first phase of the awesome new technology

or drug," Dr. Parker says. "Where I feel we are

uniquely positioned-particularly with the

human factors team, and with the medical

school's focus on health systems science—is to

enter into the latter part of the conversation.

novation or best practice," she says. "Now, how do you design it so it can be implemented

quickly, correctly, and efficiently, without

messing up everyone's day-to-day work? This

"You've got this great evidence-based in-

"An entrepreneur, particularly in the biomedical sciences, frequently thinks about that

Take the development of COVID-19 vac-

used, the process gets really, really hard."

THE DIRECTOR Mary Miller

Director of the Regional Accelerator and Mentoring Program (RAMP)

"The most critical money is the first money. When you're just getting started, a \$50,000 investment can make a big, big difference."



THE BUILDER **Greg Feldmann Executive Director and** CEO of Verge

"Maintaining the status quo is not a good strategy here. If we want to participate in the innovation economy, we need to take action because market forces alone aren't going to change things."



THE RESEARCHER Sarah Henrickson Parker, Ph.D. Chair of Health Systems and Implementation Science, Virginia Tech Carilion School of Medicine

"We'd like to think implementation of a best practice is entirely evidence based. Yet a lot of implementation comes from relationships and trust."



THE FINANCIER James Ramey, J.D. Managing Director of Middleland Capital

"We've had a lot of early success getting companies from outside the region with no previous connection to Virginia Tech or Carilion to become collaborators. They learn quickly that they don't have to spend millions building their own labs, recruiting Ph.D.s, or hiring employees in high-cost geographies."

is what the human factors team does. Our discovery process centers on implementing innovations properly, so patients get the best care possible."

Dr. Parker says she has found at Carilion an appetite to try new things and a nimbleness to gather data to figure out how to improve processes, systems, and devices for better patient care.

"We'd like to think implementation of a best practice is entirely evidence based," she says. "Yet a lot of implementation comes from relationships and trust. Maybe you can get a subject matter expert to tell you, hey, that's a good idea, but we need to tweak the implementation hardware, or that new process may not work in our context. Or, I'd be willing to give that a go. Carilion is the right size to build those critical partnerships and that trust."

Taking the Ramp

Carilion, Virginia Tech, and Roanoke have designated an innovation corridor between Carilion's Roanoke campus and downtown to provide a physical space for entrepreneurs, scientists, health providers, and those who support them to interact and build those relationships.

Within the corridor, the city joined with Virginia Western Community College and the Roanoke-Blacksburg Technology Council to create the Regional Accelerator and Mentoring Program, or RAMP.

"We're trying to help technology-based startups jump hurdles a little faster," says Mary Miller, director of RAMP. "We help them avoid wasting resources, particularly financial resources, and we try to stop them from going down wrong paths."

Ш

"Our focus is on innovations with commercial potential. Not only might our patients benefit, but if we were able to license that intellectual property to, say, a medical device company that could bring the innovation to a larger market, patients across the country, if not the globe, could benefit."

-Troy Keyser, Director, Carilion Clinic Innovation

RAMP is a twist on other mentoring accelerators started by venture capitalists looking to increase the success of startups they've backed. Roanoke's leaders viewed RAMP more as a way to encourage young companies in high-paying tech fields to grow in place.

"Many regional accelerators have demonstrated the benefits of supporting startups," Miller says. "If you show them the support that a region or community can bring to the table early in their journey, then they stay. That's the magic: the mentoring, the resources, the care and nurturing a company can receive."

Young tech companies make pitches to RAMP through a competitive process. Miller taps into a deep bench of mentors who then help the entrepreneurs learn how to develop, manage, and market their businesses. By the end of 2020, two dozen tech startups had gone through the program, and RAMP won a \$1 million U.S. Economic Development Administration grant to double its capacity. It recently added a second cohort focused only on life and health sciences.

The region is rich in mentors, Miller says, yet it needs a deeper pool of early-stage money. "The most critical money is the first money," she says. "When you're just getting started, a \$50,000 investment can make a big, big difference, but it's absolutely the hardest to raise because it's also the riskiest for investors."

Miller plans to create an angel investor group to help support early-stage startups. Rounds would raise \$500,000 with a rule that no one person can put more than \$5,000 in any one fund. Initial investments for any one company would be held to no more than \$50,000, so the investor's risk would be no more than \$500 for any one company.

"Many people have expressed an interest in this idea," Miller says. "Many potential angel investors just don't know how to get started, and this would be a new pathway. Their support would be critical, as all the research finds that companies thrive in regions where early-stage money is more available."

On the Verge

All these efforts together are accelerating innovation.

"This is not traditional economic development, where you try to land a company that will bring a hundred jobs into a box plant you built in an industrial park," says Greg Feldmann, executive director and chief executive officer of Verge, a collaboration of partners focused on supporting the region's innovation economy. "This is ground-up economic development, where you are taking many acorns and nurturing them, hoping a few turn into some pretty tall oaks."

Feldmann says Virginia is trying to catch up to its peers. In 2018, the state looked at its lifecycle of innovation and whether ideas and products were making their way out of labs and into the marketplace.

"Roughly \$11 billion of sponsored research was taking place statewide," Feldmann says. "Relative to our population and size, that was a decent number." But the study also found Virginia needed more venture capital invested before its many innovations could move through research and development and result in new companies and jobs.

"Maintaining the status quo is not a good strategy here," Feldmann says. "If we want to participate in the innovation economy, we need to take action because market forces alone aren't going to change things."

In 2020, the commonwealth created the Virginia Innovation Partnership Authority to foster greater collaborations with governments, businesses, and universities, as well as the development of regional counterparts. In southwestern Virginia, Verge was formed by joining programs from the Roanoke-Blacksburg Technology Council, RAMP, and the Valleys Innovation Council.

"If you want to understand our passion and purpose," Feldmann says, "we're trying to organize the resources we have in our own backyard strategically, so we can be a regional technology hub that generates interesting and meaningful new companies and jobs."

Through its affiliated organizations, Verge is building RAMP's capacity to help more startups, providing networking, educational programs, and talent development initiatives for the technology sector through the Roanoke-Blacksburg Technology Council. Verge is also helping address capital access issues by supporting Common Wealth Angels and building bridges to investor groups beyond the region.

VTC Ventures

While the region is what many venture capitalists consider "flyover country," unworthy of even a downward glance from a passing plane window, James Ramey, J.D., managing director of Middleland Capital, is convinced it can become a health and life science destination for innovation.

In 2016, as part of Carilion's broader investment portfolio, Carilion and Virginia Tech created a venture capital fund to invest in high-growth companies within the greater region and across the VTC ecosystem. Since inception, this initial fund has matured into multiple investment vehicles operating as VTC Ventures.

Managed by Middleland Capital, VTC Ventures has two primary funds: the VTC Seed Fund, which invests up to \$500,000 in early-stage, post-proof-of-concept companies, and the VTC Innovation Fund, which invests up to \$5 million in mature companies that are still fairly early in their lifecycles. Ramey, who oversees both funds, says Carilion and Virginia Tech have collectively contributed just over \$50 million across the funds.



Generally, portfolio companies need to be physically located near Roanoke, or have a meaningful connection to Virginia Tech or Carilion. In addition to investing in high-potential, high-performing companies in the region, VTC Ventures works with investors locally, nationally, and internationally to catalyze investment across the VTC ecosystem.

teams with strong intellectual property that are under other investors' radars, as these companies are off the beaten path," Ramey says. "We find great companies in underserved geographies, including Roanoke and Blacksburg, where we then can leverage our national and international relationships to build strong investment syndicates."

In addition to finding, funding, and helping to develop top-performing companies in the Virginia Tech Carilion ecosystem, VTC Ventures finds companies outside of the ecosystem and integrates them into Virginia Tech, Carilion, and sometimes physically in Roanoke and Blacksburg.

"We've had a lot of early success getting companies from outside the region with no previous connection to Virginia Tech or Carilion to become collaborators," Ramey says. "We then show these companies what Virginia Tech, Carilion, and this region have to offer. They learn quickly that they don't have to spend millions building their own labs, recruiting Ph.D.s, or hiring employees in high-cost geographies. These companies work with both Virginia Tech and Carilion to outsource their R&D, co-develop products, run clinical trials, and hire or contract with people in Roanoke and Blacksburg." Ramey also keeps in close contact with portfolio companies and entrepreneurs and provides them with substantial feedback and guidance.

"We're not passive investors," he says. "We work closely with our portfolio companies to help the management teams in any way we can. This includes providing strategic advice, raising capital, or introducing them to other investors or clients."

"We aim to deliver strong investment returns, and making disciplined investments in great companies enables these returns," Ramey says. "The success of these companies ultimately drives economic growth across an ecosystem. We view ecosystem growth as an intended consequence of our investment activities. One begets the other."

Ramey has felt encouraged by the growth of startups in the region during the funds' first few years.

"As we continue to string wins together, the Virginia Tech Carilion ecosystem ascends in the eyes of the world," he says. "Our aim, over time, is for entrepreneurs and financiers to stop considering this flyover country. We are working hard to help make that ecosystem a destination for cutting-edge research, entrepreneurship, and innovation both within health care and beyond."

Ramey notes that most of the nation's venture capital is concentrated in a handful of places such as Boston and San Francisco. Of the country's 3,300 counties, about 40 of them receive more than half of the funding.

"We view this as an opportunity to invest in high-quality management



Although VTC Ventures makes equity or convertible debt investments, not grants, and is focused primarily on investment returns, ecosystem growth is a key component of its mission.

CONNECTORS

CARILION MEDICINE'S SPECIAL REPORT ON INNOVATION

Innovators from across Carilion Clinic are looking for ways to use new technologies to benefit patients—and they're finding that startups can be part of the solution. by VERONICA MEADE-KELLY

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he Information Age has been all about connectivity. The boom in transformational technologies—particularly from the world of computing—has allowed people to access and transmit information and communicate with others around the world with unprecedented ease.

At Carilion Clinic, the obsession with connectivity has become embedded in its philosophy on innovation. Whether it's developing groundbreaking technologies that take advantage of connectivity to provide better care for patients, or putting researchers and clinicians in touch with the right business partners to bring new ideas and products to market, making connections is central to the process.

Perhaps nowhere is this spirit more evident than in Carilion's recent partnership-building efforts—particularly its growing maturity in working with startups. Carilion has been keen to take advantage of this open, increasingly connected environment to find new opportunities to collaborate.

As Troy Keyser, director of Carilion Clinic Innovation, explains: "Our mission is to look at our research and operations, to see what we're doing versus what nirvana might look like, then look across the marketplace to identify where we might be able to fill the gaps. We want to facilitate the development of solutions that can help not only our patients, but potentially patients across the country, if not the globe."

On-Site Navigation

Carilion has bolstered and formalized its innovation efforts over the past decade to keep pace with and take advantage of technological advances, leading to the creation of Carilion Clinic Innovation.

"The R&D portfolio had grown, so there was a natural offshoot of translatable research that had the potential to have patient impact," Keyser explains. "We needed to be able to bring those innovations to market more effectively so patients could benefit from our research."

That effort is far from a solitary one. Carilion has benefited from a rich biomedical ecosystem that, along with enabling technology, has made it easier to connect, collaborate, and identify new opportunities. Significantly, Carilion's affiliations with academic institutions such as Virginia Tech provide a pipeline of new scientific research and ideas ready to be tested in the clinic, as well as connections to entrepreneurial alumni and not an insignificant amount of funding.

Moreover, the extended network of hospitals within the Carilion system makes it easier to bring medical specialists together to collaborate and bring forward innovations of their own, along with the resources and opportunity to partner with patients to conduct proper testing of new treatments and processes.

In the arena of partnerships specifically, Middleland Capital's VTC Ventures and the LINK + LICENSE + LAUNCH program at Virginia Tech have proven to be essential, like-minded partners. VTC Ventures, under the management of James Ramey, J.D., helps identify external partnership opportunities for Carilion Clinic Innovation and others, and provides seed investment in potential new technologies. Meanwhile, LINK + LICENSE + LAUNCH—a unique program at Virginia Tech that combines the patent and licensing services of a traditional tech transfer office with the external networking expertise of a strategic partnership office—connects university researchers with appropriate partners for development.

"Sometimes people think of Virginia Tech principally as an engineering school, but life sciences-related discoveries represent a significant and important part of our asset portfolio," says Brandy Salmon, M.B.A., Ph.D., who leads LINK + LICENSE + LAUNCH as the university's associate vice president of innovation and partnerships. "The health sector constitutes 20 percent of the nation's economy and, of course, carries significant human and economic impact. Faculty and researchers across multiple colleges, institutes, and units at Virginia Tech are making discoveries and developing technologies with applications to the health sector. It's exciting to think about the potential these discoveries could offer if they were translated to the marketplace."

With the possibilities for investment continuing to grow across biomedicine, there needs to be a way to prioritize projects. For Carilion, that involves keeping patients topof-mind.

"First and foremost," Keyser says, "the question we always ask ourselves is: Will this innovation help our patients or help our providers care for our patients?"

The benefits Carilion Clinic Innovation looks for include improved diagnostics and treatments, as well as a better patient experience from appointment scheduling, through office visits and follow-up. But benefits may also extend into patients' communities.

"Part of Virginia Tech's mission-as well as Carilion's-is to promote economic prosperity and improve the human condition," says Dr. Salmon. "One way to do that is to create economic development opportunities, such as startups, that can scale, become regional employers, and create jobs. Carilion has done that in magical ways in the region, and we are looking forward to building on the momentum of both organizations to create 'the next."

Running Diagnostics

To benefit the community, potential Carilion partners need to have a regional tie-an existing footprint in the Roanoke or Blacksburg area, for instance, or a willingness to bring part of their operation to the area. That can include opening a development office in the region, or working with Carilion-affiliated investigators to develop a product or run clinical trials.

Sometimes, the potential partners are connected by school ties.

Ontera was co-founded by a Virginia Tech alumnus, William Dunbar, Ph.D. In their roles connecting people and ideas, members of the LINK team helped Dr. Dunbar and his colleagues engage with a range of potential partners and collaborators. Ramey at VTC Ventures, for example, ultimately connected Ontera with Ralph Whatley, M.D., a pulmonologist who serves on the scientific advisory board for Carilion's venture funds.

The funds took an interest in Ontera. and Carilion is now set to embark on clinical trials of a fast and easy-to-use diagnostic system Ontera is developing for COVID-19. It's a novel use of Ontera's existing system, which uses nanopore technology to detect the presence of a specified pathogen. The system consists of a cassette containing a special molecule designed to latch onto part of a pathogen of interest. A biological sample-the contents of a nasal swab, for instance—is put into the cassette, which is then inserted into a small, easily transportable machine. If the pathogen is present, it triggers a chemical reaction and an electrical signal that sets off the nanopore sensor.

The machine detects minuscule concentrations of a given pathogen, so a surface-level nasal swab should theoretically be enough to accurately detect the virus that causes COVID-19. The challenge lies in creating the right molecule to bind to the virus and trigger the sensor. Ontera developers believe they've done that hard work and now, with the help of Carilion, they're set to test it in the clinic, where they will compare the accuracy of their diagnostic system head-to-head with that of the PCR-based tests that are the current gold standard.

If successful, this faster, simpler test could be a game-changer for patients. Results return in under 20 minutes, and the machines are easy to set up and use virtually anywhere.

"This could be deployed rapidly and used by almost anyone, so long as they're trained to take a nasal swab and run the device. It's not sent out to a lab," Dr. Whatley explains. "From a Carilion perspective, that means it could be quickly and widely distributed to the more than 200 practice sites in our system even in the most remote, mountainous, and rural parts of Virginia."

And the utility of the device could extend bevond COVID-19. In fact, Dr. Whatley says, the technology first appealed to him because of its potential to detect other diseases-respiratory illnesses such as tuberculosis, for instance, or sexually transmitted infections.

"Ontera has already done proofof-concept studies for other infectious diseases. COVID is certainly timely, but I

Bringing this sort of innovation to patients across Virginia is one of the clearest benefits to working with external partners—and clinical trials remain the most common form of partnership. According to Andrea Bidanset, M.H.A., director of clinical trials at Carilion, the health system has more than 120 clinical trials open involving outside pharmaceutical and device companies, testing promising new drugs and biomedical devices. "One of the biggest advantages to having a robust portfolio of clinical trials



"Our mission is to look at our research and operations, to see what we're doing versus what nirvana might look like, then look across the marketplace to identify where we might be able to fill the gaps."

-Troy Keyser, Director of Carilion Clinic Innovation

might be more interested in the technology for other reasons," Dr. Whatley says, noting that COVID-19 might be less of a concern by the time the study concludes.

is the access it provides our patients," Bidanset says. "It has the potential to improve quality of life for people living in our region because they don't necessarily have to travel several hours to a larger, urban academic medical center to get cutting-edge treatments."

In the case of the Ontera device, the benefit is in early diagnosis. As Dr. Whatley puts it, "Imagine being able to walk into a primary care clinic, having a precise diagnosis in less than half an hour, and walking out the door with a plan or even a prescription. What more could a patient want?"



"Sometimes people think of Virginia Tech principally as an engineering school, but life sciences-related discoveries represent a significant and important part of our asset portfolio."

-Brandy Salmon, M.B.A., Ph.D., Associate Vice President of Innovation and Partnerships at Virginia Tech

Optimizing Searches

Some health care innovations are more or less invisible to patients, affecting care behind the scenes. In recent decades, the Information Age's data deluge increased demand for innovation in health care, and greater oversight of providers has translated into crushing administrative costs and strains on clinical manpower—both of which affect how patients are served and at what cost.

Carilion innovators who are looking for ways to offset these burdens are more frequently turning to health information technology to streamline administrative processes. Such machine-based solutions are now second only to medical devices in terms of investment in health care technologies.

Through VTC Ventures, one of Carilion's investments in health information technology has been in MetiStream. According to Keyser, MetiStream's natural language processing (NLP) technology came onto the radar of Carilion's chief medical information officer, Stephen Morgan, M.D., several years ago. The company specializes in delivering NLP and analysis of unstructured clinical data for patient and population insights in health and life sciences.

"Dr. Morgan thought the off-the-shelf products available from MetiStream were more than enough to justify becoming a customer," Keyser recalls. "But it was clear that there were other, unexplored applications for their platform. My office set out to find what needs at Carilion weren't being addressed by the market already, and where MetiStream could potentially help."

In addition to contracting for MetiStream's existing module for annotating and analyzing pathology reports for colonoscopy screening, Carilion is partnering with the company to develop a new product that automates the chart review process for reporting surgical quality data. Such data are requested by a range of external entities, from the American College of Surgeons to U.S. News & World *Report* to Medicaid.

"MetiStream's NLP technology essentially reads text and extracts meaning from it," explains Jacob Gillen, M.D., a trauma surgeon and critical care provider who leads Carilion's efforts with MetiStream. "We're trying to use that technology to enhance and augment what our human readers do when we submit data to NSQIP, the main surgical quality database."

Currently, human readers have to go through charts line by line to extract information—such as symptoms, treatment paths, and outcomes-to report into NSQIP (the National Surgical Quality Improvement Program). NSQIP then returns valuable data that benchmark Carilion's care against that of other providers across the country. The results help Carilion surgeons recognize areas of weakness and make improvements.

While valuable, the collection of such data is labor-intensive and comes at a cost. limiting how much information Carilion can report. MetiStream's NLP uses machine learning to make quick work of the text. The technology-dubbed the Surgical Clinical Reviewer module—is trained to identify specific variables; Dr. Gillen estimates that NSQIP considers more than 180 variables. The NLP then scans documents quickly for those variables, then quantifies and reports results.

Dr. Gillen likens the process to a highly sophisticated version of the "find" function on a PDF or the way Google rapidly returns results from search queries. Human reviewers can then check that work for accuracy instead of having to read every word of text.

"The idea," Dr. Gillen says, "is to increase the volume of patient charts that we can submit, to get more and better data on our outcomes—and then use that to drive better care for our patients."

Carilion recently executed a collaboration and license agreement with MetiStream to co-develop the Surgical Clinical Reviewer module, which the partners believe has the potential to improve patient care nationally and internationally. Already the module is being used to detect adenoma rates for identification of patients at high risk for colon cancer.

Minutes Instead of Months

While partners can bring technological elements and expertise to the table, there's no shortage of innovation within Carilion's walls.

ArchiveCore is a startup founded by two Carilion physicians, Keel Coleman, D.O., an emergency medicine provider, and Lennox McNeary, M.D., a physical medicine and rehabilitation specialist. The company evolved out of conversations they were having several years ago, when Dr. McNeary was voicing frustration about delays in the medical credentialing process. Dr. Coleman, who was studying business at the time, had become fascinated by the ability of distributed ledger technology (DLT) to verify and secure identity.

"It seemed obvious to both of us that DLT could be used to solve the medical credentialing problem," says Dr. McNeary. "It was a solution looking for a problem, and we had a use case looking for a solution."

Medical credentialing is an essential process required before any medical specialist is

"The grim side of that process is, if you're hiring a new specialist, they're needed in that place at that time, so the delay in credentialing becomes an access issue for patients," Dr. McNeary says. "And on the health care revenue side, having that clinician sidelined costs the system about \$7,000 a day in lost revenue, so the wait hurts health care institutions as well."

ArchiveCore uses DLT to secure medical credential records and make them readily available for hiring institutions to speed up the credentialing process. A distributed ledger is essentially a secured spreadsheet of sorts that is available on the internet to anyone with access. Perhaps the most commonly known use of DLT is blockchain for securing cryptocurrency.

ArchiveCore's DLT allows credentialing institutions to log a document, such as a diploma or license, which is then "hashed," or turned into a single line of encrypted code. That entry is also marked in the ledger, or spreadsheet, which is also secured. Users can then see the record of the transaction and get a copy of the original, hashed document, which has been stored and encrypted, through a secured email service. As long as the verified and secured records are on file, the credentialing process could take minutes instead of months.

"Part of the beauty of the system is that it's institution agnostic, so no matter where in the world a clinician trained, the credentialing process would be accelerated," says Dr. Colemen. "We are hoping this in-house innovation can be adopted more broadly to help health systems across the country." Here, too, Carilion's commitment to fostering innovation has helped, by providing the resources needed to pilot ArchiveCore's technology. "That partnership has been critical to us having access to the world of

FEATURED CASE STUDIES

ArchiveCore

A startup founded by two Carilion physicians, ArchiveCore uses distributed ledger technology to verify and secure records of medical credentials, making them readily available to hiring institutions. As long as a clinician's verified and secured records are on file, the credentialing process could take minutes instead of months, speed that's crucial when specialists are critically needed.

MetiStream

A health care analytics company, MetiStream uses natural language processing technology to scour charts for such information as symptoms, treatment paths, and outcomes. MetiStream and Carilion are co-developing the Surgical Clinical Reviewer Module, which is already being used to detect adenoma rates for identification of patients at high risk for colon cancer.

allowed to start work in a health care facility. It's needed to ensure that those hired to provide care indeed have the proper training to do so.

When a new doctor is hired, his or her education and other medical credentials need to be verified. The process takes three to four months on average, during which the hiring clinic exchanges countless phone calls and faxes with offices at the various institutions where the doctor worked or studied. Since medical education spans several years and multiple locations-often in different states—the process is arduous.

graduate medical education, the credentialing verification office, and the health system so we can test the technology and make improvements," Dr. Coleman says. "We are grateful for our partnership with Carilion."



Ontera

A diagnostics company, Ontera uses nanopore technology to detect the presence of even minuscule concentrations of specified pathogens. With the help of Carilion, Ontera is ready to embark on clinical trials of a fast and easy-to-use diagnostic system it has adapted for COVID-19. The trials will compare the accuracy of the nanopore system with that of PCR-based tests, the current gold standard.

GAME CHANGER: Dr. John Tuttle realized he could help patients get back in the game with his soft-tissue fixation button, a device for soft-tissue-to-bone surgical repair.





A sports medicine physician has translated his passion for helping injured athletes get back in the game into an innovation that marries the fields of medicine, engineering, and design. by JESSICA CERRETANI | photographs by JARED LADIA

ohn Tuttle, M.D., didn't intend to transform orthopaedic surgery. The sports medicine physician was simply trying to solve a nig-

gling problem he often encountered in practice: fixing soft tissue to bone when repairing an injury. While it's a common procedure for those in orthopaedics and sports medicine, the technique can be challenging, and

success depends on a variety of factors. "I knew there had to be a better way to do it," he says. Now, thanks to an inspired collaboration with Prachi Joshi, who leads in-

vention development with a background in biomedical engineering, and the rest of the team at Carilion Clinic Innovation, Dr. Tuttle is moving a surgical "what if" closer to a game-changing reality. Known as the soft-tissue fixation button, the invention, says Joshi, "is different from anything else that's currently out there."

Identifying a Surgical Challenge

Dr. Tuttle has spent his career helping injured athletes-from weekend warriors to professionals—get back in the game.

A childhood love of basketball, baseball, and football while growing up in Ohio eventually led him to a fellowship in sports medicine at Northwestern University, where he helped provide care to players on teams such as the Chicago Cubs, Bears, and Blackhawks. Since joining Carilion Clinic in 2017, he's worked with some local teams, including those from the Virginia Military Institute, Southern Virginia University, and Washington and Lee University.

"I've always felt really at home on the sidelines and in the locker room," he says. "I enjoy working with this patient population because they're so motivated to get back to a high level of functioning."

In treating athletes, Dr. Tuttle has become intimately familiar with sports injuries and their repair. One such repair involves reattaching tendon to bone following a tear. This can occur with the biceps tendon, particularly the long head of the biceps tendon, which connects the biceps muscle to the shoulder socket. Unexpected force—falling on an outstretched arm or lifting a heavy weight, for instance—can damage the tendon, as can repetitive motions and long-term overuse.

Minor tears don't always need treatment, but people who especially depend on the strength and function of their biceps tendons, such as athletes and manual laborers, often require surgical intervention.

THE CHALLENGE-TO-DISCOVERY PHASE



THE PROBLEM: "Each patient has a natural tension relationship between the tendon and bone," Dr. Tuttle says. "It can be difficult to determine how much tendon to cut."

THE EUREKA MOMENT: "I had a lightbulb moment," Dr. Tuttle says. "It occurred to me I could use this anchor as a springboard for a new type of soft-tissue fixation. My wheels started turning."



THE SOLUTION: Working with Prachi Joshi and the rest of the Carilion Clinic Innovation team, Dr. Tuttle has been able to perfect a prototype to make his soft-tissue fixation button a reality.

These days, surgeons usually repair such ruptures and tears arthroscopically; both physicians and patients tend to prefer this minimally invasive approach. The challenge, says Dr. Tuttle, comes in successfully fastening the tendon to the bone. When repairing a long head of the biceps tendon, the tendon can either be cut and released or, preferably, cut and then attached to the humerus bone in the upper arm.

The problem: "Each patient has a natural tension relationship between the tendon and bone," says Dr. Tuttle. "It can be difficult to determine how much tendon to cut so we can reestablish and maintain that tension once the tendon is reattached."

Dr. Tuttle knew what he and his colleagues wanted: a way to fix the tendon to the bone *before* they cut it. But creating that solution would take more than just wishful thinking. There was much to consider.

"It would mean coming up with something that offered secure fixation, minimized the amount of tendon to be removed, maintained the force coupling of tendon to bone, was reliable, and-most importantwas achievable technically," he says. "I kept thinking about it, going through many trialand-error scenarios in my head."

Then, just a few years ago, the solution began to crystallize when a new knotless anchor hit the market. This innovative surgical device allows physicians to drill into bone, attach a suture, and lasso soft tissues to the area without tying knots.

"I had a lightbulb moment," Dr. Tuttle says. "It occurred to me I could use this anchor as a springboard for a new type of softtissue fixation. My wheels started turning."

Back-of-the-Napkin Idea

Around the same time, Joshi was transitioning from the National Institutes of Health's Pitt Clinical and Translational Science Institute to a new role as innovation manager at Carilion Clinic Innovation. Under the leadership of Troy Keyser, she manages the department's proof-of-concept program, guiding early- to mid-stage innovation projects from ideation to possible commercialization-all with the ultimate goal of improving patient care.

For Dr. Tuttle, it was perfect timing. He had finally devised what he thought was a viable solution to the challenges of tendon repair: a button that could be secured to the new knotless anchor. As with a button on a shirt, this approach would allow surgeons to affix soft tissue onto bone, where, that fixation?"



"Prachi and her team have been ready to help me every step of the way, and that's allowed me to focus on my clinical practice while really getting this innovation moving." —John Tuttle, M.D.

over time, that tissue would eventually establish itself. "It was one of those back-ofthe-napkin ideas," he says, referencing the classic brainstorm sketched roughly onto a cocktail napkin.

"I'm not sure if we even had a sketch when we started," Joshi says. "But Dr. Tuttle had an idea, and the way he was able to articulate that idea and its potential clinical impact really drew us in." Intrigued, she and the team told Dr. Tuttle they were on board.

What happened next was the ultimate collaboration between the fields of medicine, engineering, and design. Working with one of the team's engineers, Dr. Tuttle refined his idea based on computer-aided design models, which were 3D-printed as prototypes in Carilion Clinic Innovation's makerspace, tested, and refined yet again—a

occur during clinical care. "My patients inspire me to keep searching for new answers to issues that arise," he says. "I'm full of ideas for the future."

process that took about eight months. Now, working with a final prototype, Dr. Tuttle has begun testing both the button and the procedure itself.

"We believe that it's an easier, faster, and more reliable approach to softtissue fixation," he says. "But the biggest question remains: How strong is

To learn more, Kendall Carter, a student at the Virginia Tech Carilion

School of Medicine, is leading a project that compares Dr. Tuttle's prototype to a commercially available button and explores alternative techniques that test the approach from a biomechanical standpoint. Together, they are conducting in-vitro testing in tissue-based models to determine the clinical relevancy and biomechanical properties of the latest prototype.

Austin Petty, an undergraduate at the Virginia Tech College of Engineering, and his mentor, Vincent Wang, Ph.D., an associate professor of biomedical engineering and mechanics, will analyze the study samples using a biomedical apparatus they've designed. They expect to have preliminary results later this year.

A Dream Almost Realized

Meanwhile, Dr. Tuttle has filed a patent for his innovation. The goal, he says, is to get a working product on the market that expands surgical options and provides physicians with a new way to help patients. "I've never tried anything like this before," he admits. "I have many ideas and 'wouldn't it be nice' notions, but now this is more than just a whimsical thought. It's starting to become a concrete product and a real option."

It's a dream almost realized—and one he believes wouldn't be possible without Joshi and Carilion Clinic Innovation.

"I don't have the time, resources, or expertise to create something like this on my own," says Dr. Tuttle, who joined Carilion because he wanted the opportunity to teach, conduct research, and explore innovation in addition to providing patient care. "Prachi and her team have been ready to help me every step of the way, and that's allowed me to focus on my clinical practice while really getting this innovation moving."

For Joshi, it's a prime example of why she, too, landed at Carilion. "Our vision is to help develop inventions that have a real clinical impact and that can be realized broadly through commercialization," she says. "We provide the resources and give inventors everything they need to create and play. Dr. Tuttle is the clinical expert. My job is to enable him to do what he loves."

And Dr. Tuttle has no plans of stopping. Although it's too early to share the details, he's working with Joshi and Carilion Clinic Innovation on several other projects, too—all stemming from the challenges and questions that

ANATOMY OF A DISCOVERY CARILION MEDICINE'S SPECIAL REPORT ON INNOVATION

Experts cross disciplines to enable the rapid diagnoses of mild traumatic brain injuries at risk for serious, long-term effects.

Brain Injuries Decoded

Several million new mild traumatic brain injuries occur each year in the United States, mostly because of falls, auto accidents, and sporting mishaps. Many patients with the condition will heal quickly, but others may develop prolonged and disabling physical and emotional symptoms. Patients at risk for more serious effects from their injury must be identified quickly, to ensure the best outcome possible.

In 2018, an interdisciplinary team joined to create BRAINBox, a handheld device that enables a blood-based test to be administered directly at the point of care, providing rapid results. The test also aims to provide short- and long-term prognoses, including identifying early those at risk for prolonged or severe effects from their injury.

November 2012

The Richmond, Virginia–based diagnostics firm ImmunArray licenses a panel of brain injury markers developed by Johns Hopkins University researchers Jennifer Van Eyk (now at Cedars-Sinai Medical Center) and Allen Everett.

January 2014

ImmunArray receives a \$300,000 grant from the GE NFL Head Health Challenge to further develop the Johns Hopkins panel of brain injury markers.

December 2018

ImmunArray spins off a new company, BRAINBox Solutions, Inc., to commercialize tests for diagnosing and monitoring mild traumatic brain injury.

Virginia Catalyst awards a

\$500,000 competitive grant to a collaborative bioscience commercialization project including a team from the Virginia Tech Carilion Research Institute (now the Fralin Biomedical Research Institute at VTC), the University of Virginia, Carilion Clinic, and **BRAINBox Solutions.**

June 2019 The U.S. Food and Drug

Administration grants **BRAINBox Solutions a break**through designation for it first-of-kind device to aid in the diagnosis and prognosis of concussions. Virginia Tech, with the Fralin Biomedical Research Institute and its clinical partner, Carilion Clinic, serves as one of the national anchor research and clinical sites to validate the test. Faculty members with the University of Virginia Health System perform parallel diagnostic blood tests, neuroimaging, and neuropsychological studies.

How BRAINBox Works

BRAINBox's Principal Collaborators



Stephen LaConte, Ph.D. Associate Professor, Fralin Biomedical Research Institute at VTC

"One of BRAINBox's goals is to go beyond diagnosing mild traumatic brain injuries and provide prognoses. We want to predict short- and longterm outcomes, including identifying those at risk early for prolonged or severe effects from their injury."



Damon Kuehl, M.D. Vice Chair of Emergency Medicine, Carilion Clinic

"These injuries are some of the most challenging to diagnose. Other than using a CT scan to look for bleeding and doing a basic assessment of ability to function when the patient presents, we still don't have really good diagnostic tools to find out which patients will do poorly and which will be fine."

core component of the BRAINBox system is a bloodbased biomarker test that can be administered in an emergency department, an urgent care center, a clinic, or even eventually a sports field to provide a rapid-result assessment of a mild traumatic brain injury and a prognostic view of a patient's likelihood of post-concussive symptoms.

The system uses a multianalyte immunoassay to identify specific proteins that have leaked from injury-damaged cells in the brain. The patient's blood sample is placed on a small cartridge, which is inserted into a handheld device that can rapidly measure molecules and identify the proteins that have been released.

The panel of biomarkers is then paired with a functional assessment on a tablet. The functional component stems from validated neuropsychiatric testing and cognitive assessments delivered through an artificial intelligence-driven algorithm.

The BRAINBox system integrates the biomarker data and the neurocognitive assessment to produce a single simple and easy-to-understand score. The integrated score appears within a half hour.

Clinicians can also conduct balance and coordination assessments to complement that score for a more complete diagnosis and prognosis.



September 2019

The U.S. Patent and

Trademark Office expands BRAINBox Solutions' patent on its multi-modality approach by adding a portfolio of biomarkers that have characteristics for diagnostics, such as robust levels in concussion and mild traumatic brain injury, extended kinetic profiles after injury, and a strong correlation to subtle microvascular injuries that are more difficult to assess. The biomarkers are novel astrocyte-injury-defined biomarkers, including Aldolase C or a trauma-specific breakdown product of Aldolase C.

December 2020

BRAINBox Solutions raises \$23 million. Bioventures Investors takes the lead in the Series A financing, with the Tauber Foundation, the Virginia Tech Carilion Innovation and Seed Funds, Genoa VC, Pharmakon Holdings LLC, Astia Angels, and qualified investors participating in the fundraising round.

March 2021

BRAINBox Solutions enrolls its first patient in a clinical trial for those with a mild traumatic brain injury. Carilion is providing leadership as one of three key centers for this international, 28-site trial, which is expected to enroll up to 2,000 patients.



Donna Edmonds Chief Executive Officer, BRAINBox Solutions, Inc.

"This is a game changer. The brain is extremely complex, and to understand what is going on during a head injury requires a multi-biomarker, multi-modality approach."



Michael Friedlander, Ph.D. Executive Director, Fralin Biomedical Research Institute at VTC

"This research represents a collaboration of creative scientists and physicians who are committed to the power of large-scale, rigorous scientific testing to advance the diagnosis of mild traumatic brain injury."



The_Next_Wave

Together Carilion Clinic and Blue Ridge Cancer Care are helping to pioneer a new method for treating cancer. Theranostics uses molecular radiotherapy to target and treat tumors with precision. BY DAVID BUMKE Anita Haymaker had already been through a lot. Several years ago, although she felt generally healthy, "I was breaking out all over," she says. So she saw her doctor, who ordered tests that led to her first cancer diagnosis: a neuroendocrine tumor in her pancreas.

A Better Way to Target Cancer

Haymaker had surgery to remove the tumor, but two years later the cancer returned, this time in her liver. She had another operation and, when the cancer came back again, she had a hysterectomy. "After that, my doctors said they didn't think I was a candidate for any more surgery," says Haymaker, who lives with her husband, Kenny, on Smith Mountain Lake, southeast of Roanoke.

But doctors found more cancer in Haymaker's pancreas and liver, and she began receiving chemotherapy at Blue Ridge Cancer Care. That's when her doctor suggested she see David Buck, M.D., president of Blue Ridge Cancer Care and medical director of Radiation Oncology at Carilion Clinic's Cancer Center.

Dr. Buck also serves as chair of Carilion's oncology committee and head of radiation research for the U.S. Oncology Network, of which Blue Ridge Cancer Care is a part. He was recruiting patients for a trial of a radioactive compound called lutetium dotatate.

In Haymaker's meeting with Dr. Buck, he explained that this new treatment was being tested in patients whose tumors were no longer responding to other therapies. If she chose to participate in the trial, she would receive multiple treatments, spaced about six weeks apart. Although the infusion of the radioactive compound itself would take only half an hour or so, she would also receive intravenous amino acids before and after to help protect her kidneys, so she should expect to be at the clinic for most of the day for each treatment.

"He told me they would bring the drug in a little metal box because it was nuclear," she remembers. She found that a little disconcerting, like something out of a science fiction movie. But with the effectiveness of other treatments fading fast, she felt she had little choice but to give this experimental therapy a try. "Sign me up," she told Dr. Buck.

Lutetium dotatate, now marketed under the name Lutathera, is one of several injectable radiation therapies now being tested or already in use. This form of precision medicine goes by a catchy name theranostics-because it uses radioactive isotopes for both diagnostics and therapy. The special compounds are used to locate tumor cells and then to destroy them.

"Employing radioactive therapies against cancer isn't new," says Dr. Buck. "What has changed is the degree to which they can be precisely targeted to attack tumor cells while sparing healthy cells."

Historically, Dr. Buck adds, the trouble has been that these treatments weren't specific enough. "The hallmark of all of these therapies is that they emit very high energy radiation that extends over only a very short distance," he says. "That's perfect for going after cancer cells, but only if you can direct them to exactly the right places, where the tumors are."

What you need to find, says Dr. Buck, is a kind of cellular receptor that exists only on tumor cells. The next challenge is to identify an imaging agent that can zero in on that particular receptor. In the case of carcinoid tumors, a kind of neuroendocrine tumor, that imaging agent is a radioactive compound known as gallium dotatate. After being injected, it seeks out and attaches itself to carcinoid tumor cells. Then, a positron emission tomography (PET) scan can show exactly where in the body the tumor cells are and how extensively the cancer may have spread.

That's the diagnostic part, says Jackson Kiser, M.D., chief of molecular imaging in Carilion's Department of Radiology. The big recent advances in nuclear medicine therapy came when researchers realized they could pair the precision of an imaging isotope such as gallium dotatate with other types



"He told me they would bring the drug in a little metal box because it was nuclear." —Anita Haymaker, Patient

standard chemotherapy and radiation, which home in on cells that are dividing quickly. But carcinoid tumor cells do have a unique receptor, which can be targeted with a drug called octreotide. Even then, however, the effects tend to decrease over time.

of radioactive materials that can be used to destroy tumor cells, Dr. Kiser says.

That second kind of material includes alpha and beta emitters that can get into the machinery of cancer cells and disrupt their DNA, according to Dr. Kiser.

"Alpha emitters cause double-strand DNA breaks, destroying the DNA," he says. "We don't have many alpha-emitting therapeutics, but we have several kinds of beta emitters, which cause single-strand DNA breaks that destroy a cell's DNA production. In both cases, they can render a tumor unable to replicate itself."

To develop Lutathera, scientists removed the gallium in gallium dotatate and replaced it with lutetium, creating lutetium dotatate. "That pairing, of gallium dotatate and lutetium dotatate," says Dr. Kiser, "was the breakthrough that made theranostics possible."

Improvements in Quality of Life

Carcinoid tumors are rare, affecting only about 8,000 people a year in the United States, and they grow very slowly. That makes them a poor match for

In an important clinical trial, Lutathera was tested against an increased dose of octreotide to determine which did a better job of controlling patients' carcinoid tumors. After two and a half years, octreotide was still working for only one in 10 patients. But the tumors of two-thirds of the patients who received Lutathera continued to be controlled after the same amount of time. "It was a dramatically positive study," says Dr. Buck. "And it got people excited about the possibilities for this kind of therapy."

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Now, although anyone with a carcinoid tumor will still be treated with octreotide initially, "the minute they progress, they now go on Lutathera," says Dr. Buck.

Dr. Kiser notes that for many patients with these tumors, any relief is welcome. "Often, they're just miserable," he says. "Many have severe, almost constant diarrhea." There's a kind of preclinical trial called an expanded use protocol, also known as "compassionate use," and when it was announced

that Carilion, under that protocol, was going to be able to provide lutetium dotatate to a handful of patients, Dr. Kiser started hearing from people all over the country who were desperate to participate.

"I had to tell them we could only enroll six patients," he says. "We had to see whether this thing would work." But once Lutathera was approved, Carilion could treat anyone for whom it was an appropriate therapy. "We were among the first in the country to offer this," says Dr. Kiser.

For most patients, Lutathera isn't a cure, but it has extended patients' lives and made them much more comfortable. "In the trials that were done in Europe, before this treatment came to the United States," Dr. Kiser says, "patients were having up to five years of progression-free survival. That basically means that although the cancer is still there, you've rendered it unable to grow or spread. And for cancer, adding five years of progression-free survival is a home run."

New Hope for Prostate Cancer

Now the search is on for other receptors that exist only on a particular kind of tumor cell, and not also on cells in healthy tissue. And one of the most exciting of those involves prostate cancer, the second-leading killer (after lung cancer) of men who die from cancer. In 2020, nearly 250,000 men in the United States were diagnosed with prostate cancer, and about 34,000 died from the disease.

The FDA recently approved two PET imaging drugs for men with prostate cancer that bind to something called prostate-specific membrane antigen, or PSMA. Because most prostate cancer cells seem to have elevated levels of the antigen, PSMA has emerged as an important target for prostate cancer imaging. That's beneficial for diagnostic purposes, helping physicians see where a man's cancer is and how far it has spread.

"Fortunately, we can approach this in the same way we go after neuroendocrine cancers," says Dr. Kiser. "Once you've identified the extent of disease using a radiolabeled PSMA agent, you can take the diagnostic isotope off and put lutetium on." That produces a therapeutic agent, lutetium-PSMA, that can seek out and destroy the cancer cells.

In June, results from a clinical trial of that compound in men who had exhausted other treatment options showed a six-month improvement in impeding the proliferation of cancer cells and a fourmonth improvement in survival.

"Those are significant gains in patients who had already failed hormone therapy and chemotherapy," says Dr. Buck. But what if the theranostic agent were given earlier, in combination with—or even instead of—other therapies?

"Now they're beginning to test when the best time is for this treatment," says Dr. Buck. "Should we do it right after someone has failed hormone therapy? Should we do it when someone walks in the door with a prostate cancer diagnosis?"

Two large U.S. clinical trials are now examining the questions of when and how to use the PSMA theranostics approach.

What's Next for Theranostics?

Dr. Kiser is extremely optimistic about what the future holds for theranostics. "This is simply one of the most exciting things to happen in cancer therapy," he says. "The list of what can be treated is almost endless."

Beyond neuroendocrine and carcinoid tumors and prostate cancer, that list includes lymphoma, meningioma, thyroid cancer, glioblastoma, and other malignancies.

"Breast cancer is one particularly promising frontier," Dr. Kiser says, "as there can be three types of receptors, and some breast cancers have all three."



"Employing radioactive therapies against cancer isn't new. What has changed is the degree to which they can be precisely targeted to attack tumor cells while sparing healthy cells." —David Buck, M.D.



exciting things to happen in cancer therapy. The list of what can be treated is almost endless." —Jackson Kiser, M.D.



Those include receptors for estrogen and progesterone as well as for a growth factor called HER2.

There's already an imaging agent that can help locate the estrogen receptor, and although it doesn't yet have an associated therapeutic that could kill targeted tumor cells, Dr. Kiser and his team at Carilion have applied for intellectual property protection for such a compound that they hope to develop with a private company.

"What's exciting is that you don't have estrogen receptors just in breast cancer," he says. "They're also found in several other types of cancer. And you can target the progesterone receptor, and there's a therapy, Herceptin, that targets the HER2 receptor. Think of the wallop you could pack with all of those therapies. You could really blow up the cancer."

If a cancer has a specific receptor or a metabolic pathway associated with it, and if there's an imaging agent that can target that receptor or pathway, "then you should be able to put something therapeutic, an alpha or beta emitter, on that agent," Dr. Kiser says.

"I call this designer therapy, because it's specific to the patient. One patient with lung cancer might have one kind of receptor and another patient may have a different one. This way, you can give each of them the right therapy."

Another fascinating possibility involves a diagnostic agent called fibroblast activation protein inhibitor, or FAPI. "Most kinds of cancer make a type 2 fibroblast; it's something only cancers can produce," says Dr. Kiser. "You can image the fibroblast with FAPI and basically see the extent of the disease. That gives you another way to image and potentially treat many kinds of cancer."

There are potential risks involved with theranostics that need to be acknowledged or overcome, Dr. Kiser says. "Even when it's targeted, radiation can cause collateral damage," he says. "There can be bone marrow damage, particularly if you're treating myeloma, which likes to live in the bone marrow."

The radiation targeted to that tumor could harm the bone marrow, leading to a low count of white bloods cells or platelets. Radiation could also stay in the bloodstream and damage the kidneys as it makes its way into the urine and out of the body. But bone marrow tends to repair itself, and that's why patients receive those infusions of amino acids, to protect the kidneys.

There's also a problem of getting radioactive agents from the reactors or cyclotrons where they're produced to the hospitals or clinics where they're administered to patients. These are short-lived compounds, and time is of the essence in theranostics.

Yet there are few significant impediments to the kind of future for theranostics that Dr. Kiser and many others have described. And Carilion Clinic and Blue Ridge Cancer Care, pioneers in this approach to treating cancer, expect to be at the center of those advances. Additional research collaborations offer the opportunity for other radiotracers and radiotherapeutics to be developed in the Roanoke region, and Carilion is building new infusion centers and reaching out to global partners.

"We want to be one of the superior sites in the country for these therapies," Dr. Kiser says.

Enjoying Life with the Grandkids

Anita Haymaker's treatment with Lutathera has exceeded almost everyone's expectations. "I can't say that I'm cured," she says. But four years after she first spoke with Dr. Buck, her cancer is almost completely gone, and so far, her periodic scans have shown no progression.

Haymaker, now 76, spent part of this past summer with her grandchildren. "We live at the lake," she says, "and they go in and out of the water the entire time."

BACK IN THE SADDLE:

Randy's goal was to ride her horse without supplemental oxygen. That goal became a reality when she received her endobronchial valve.

by Marcia Lerner

FOUR YEARS AGO, RANDY AYERS OF RURAL GOODVIEW, VIRGINIA, did something many lifelong smokers find impossible: She quit. Yet that victory gave her scant comfort. By then she was already suffering from emphysema, a condition that falls under the umbrella of chronic obstructive pulmonary disease (COPD). Although only in her 60s, Ayers had trouble walking distances, and even taking a shower had become a terrifying ordeal. "You lose your breath, and it's very scary," she says. But the worst part for Ayers, an avid equestrienne, was no longer being able to ride her beloved gelding, Waylon, whom she's owned for 25 of his 30 years. Even with oxygen at her side, Ayers says, "I would go to the barn to brush him for a few minutes and then I'd get winded. That's all I could do. It was too hard to ride." She adds, simply: "I quit smoking too late." Then, in 2019, Ayers made an appointment with Maria del Mar Cirino-Marcano, M.D., a pulmonary specialist at Carilion Clinic. Dr. Cirino-Marcano told Ayers about an endobronchial valve, a device

ENDOBRONCHIAL VALVES-A RELATIVELY NEW TREATMENT FOR CHRONIC OBSTRUCTIVE PULMONARY DISEASE IN THE UNITED STATES-HAVE PROVED LIFE-CHANGING FOR SOME PATIENTS.

BREATHING EASIER



WITH HYPER-INFLATION. SOME PARTS OF THE LUNG GET DESTROYED. **THELUNGS BECOME LIKE** STRETCHED-OUT BALLOONS. THEY GET REALLY, **REALLY BIG.**"

-Maria del Mar Cirino-Marcano, M.D.

that can help some people with COPD, and she wondered whether her patient might be a candidate for it.

"When I interview patients to see whether they qualify for the valve, I ask them what their plans are," says Dr. Cirino-Marcano. "And Randy was clear about what she wanted. 'I want to ride my horse,' she told me, 'and if I can do it without supplemental oxygen, even better."

A Better Quality of Life

Endobronchial valves are small, specialized devices that are implanted in the lungs to close off airways leading to diseased areas and to allow greater airflow to healthier areas. With the lungs not working as hard to deliver oxygen, patients often find they can breathe easier and resume routine activities with less shortness of breath, says Edmundo R. Rubio, M.D., chief of Pulmonary and Critical Care Medicine at Carilion.

The valves don't cure COPD: so far, cures for the chronic condition are elusive. What they do quality of life.

"If you can breathe easier, you have more stamina," Dr. Rubio says. "As activity increases, patients may feel more energetic. They're better able to eat, and they sometimes feel less depressed. One thing leads to another."

After months of delay because of the COVID-19 pandemic, Carilion launched an endobronchial valve program in the summer of 2020, with Ayers among the first of a handful of recipients. Nationally, studies are still underway to determine more precisely their long-term effectiveness. Yet the results so far are encouraging—and for people like Ayers, relief can't come fast enough.

The region Carilion serves has an unfortunate abundance of patients with COPD. This is tobacco country, and southwestern Virginia has the state's highest rate of smoking-18.1 percent of residents, compared with just 7.7 percent in Northern Virginia.

"It's a prevalent condition" says Dr. Cirino-Marcano, "and in any pulmonary clinic, people with COPD make up the bulk of the patient population."

The Perfect Candidate

Endobronchial valves aren't right for every patient with COPD, according to Dr. Rubio. "Candidates include those with some mobility

who have had a significant impact on their daily activities," he says. "You want someone who can walk in the range of 100 to 500 meters. Those unable to walk 100 meters may not be able to tolerate the procedure, while someone who can walk, say, 1,000 meters or more without severe discomfort may not need it."

Although Ayers could still walk short distances, decades of smoking had damaged her lungs. Over the years, smoking can destroy the lung's alveoli, which are responsible for exchanging oxygen and carbon dioxide. Smoking can also cause the narrowing and scarring of airways, known as remodeling, and it can enlarge the lungs, a condition known as hyperinflation.

"With hyperinflation, some parts of the lung get destroyed," says Dr. Cirino-Marcano. "The lungs become like stretched-out balloons. They get really, really big."

When inhalations introduce a large volume of air into the lungs, the recoil of that "balloon" is insufficient to expel all of the air. "That's part of the reason for shortness of breath," says Dr. Cirino-Marcano. "The lungs offer, says Dr. Rubio, is the potential for a better are so big they've stretched the muscles that help us breathe, and those respiratory muscles don't work well anymore."

For more than a century, physicians have been searching for a safe, effective way to reduce the size of the hyperinflated lungs of COPD patients. In some cases, surgery is the answer. "With the perfect candidate, surgery can be very beneficial," Dr. Cirino-Marcano says. But surgery can have significant complications, she adds, and it's helpful if only the upper parts of the lungs are affected. For a much greater number of patients, endobronchial valves inserted into the lungs can be an effective alternative.

The Procedure

During an evaluation before the procedure, a CT scan is used to assess damage to the lungs. Then, with the patient under anesthesia, pulmonologists advance a balloon that allows them to block an airway, essentially simulating what would happen if they were to put the valve there. They need to make sure the damaged part of the lung will deflate.

If that test succeeds, the balloon is removed and an endobronchial valve is inserted in its place in a minimally invasive, nonsurgical procedure using a flexible bronchoscope. The valve is designed to let air escape from the damaged area, but not enter. If the airway is

too large, doctors may instead place multiple valves on smaller airways feeding that section. The procedure typically takes 20 minutes to an hour.

Recovery time for most patients is minimal; they awaken within two hours and are quickly able to eat, get out of bed, and walk. Most remain in the hospital several days for observation, however, to ensure no new air leaks have developed.

Breathing Freely

After the procedure, improvement comes gradually. Immediately afterward, patients may even see their symptoms worsen.

"By around the third day, most people are the patient's life. back to where they were, and after about a few weeks, they'll tell me they're able to take a deeper breath than before," says Dr. Cirino-Marcano. "Then, every time I talk to them, there will be something else they can do. They may say, 'Now I'm able to talk longer without getting out of breath.' And the next time, that shower that used to take an hour may take 20 minutes. One patient was excited because she could get into her neighbor's pool for the first time in years. Another, who works in a supermarket, was thrilled to be able to walk up and down the aisles without feeling short of breath."

Ayers experienced steady improvement following her procedure in September 2020. Although she still gets winded with exertion and keeps her oxygen nearby, she has been able to resume activities that once seemed impossible. "Taking a shower is a lot easier," she says. She can slowly climb stairs, and she even bought a treadmill and a stationary bicycle.

A moment of truth came when she went to lead Waylon around the arena for the first time in ages, wondering whether he would still "follow me around like a puppy," with no lead line, as he had always done in the past. To her immense gratification, he stayed behind her step for step. And that made everything worthwhile.

Well-Tested in Europe

The first endobronchial valve-the Zephyr Valve, now manufactured by Pulmonx-was approved by the U.S. Food and Drug Administration in 2018. But it has been around for much longer.

Dr. Cirino-Marcano was involved in the first U.S. trial when she was a fellow at the

For the COPD treatment to succeed, patients will typically receive three to five valves. Although the valves can be quickly and easily removed if a problem arises, most patients do well with them. As long as the valves are helping, they can stay in place for the rest of

"One thing the endobronchial valve procedure has taught us is that not all patients with COPD are the same," she says. "Although the valves can help a large swath of patients, they aren't for everyone."

Other patients need other solutions. "In the workup for this procedure, we look at other factors associated with COPD," Dr. Cirino-Marcano says. Carilion runs a pulmonary hypertension clinic that identifies the causes of the disease and the best therapies for each patient. Some patients may be referred for possible surgery or even a lung transplant.

Triumphant Outcome

took first prize. 🖾

Tulane University School of Medicine in 2005. and the valve has been available in Europe for almost 20 years. In the United States, doctors have used the valve to alleviate other conditions—such as bronchopleural fistulas, a serious condition often associated with lung cancer surgery—for years.

That long experience, involving thousands of patients, has been reassuring. "They have good safety data," says Dr. Cirino-Marcano.

A Range of Possible Solutions

Dr. Cirino-Marcano says that most patients with COPD tend to end up with a variation on the same treatment. Typically they're given an inhaler with either a bronchodilator or a steroid, and they may also be given oxygen.

At Carilion and across the United States, endobronchial valves are still in their infancy as a treatment for COPD. As Dr. Rubio notes, more time and more procedures will be needed to get firmer numbers on the percentage of patients who experience improved breathing, and whether the valves truly enable better oxygenation in the lungs, thus freeing more people from oxygen machines.

Yet for Ayers, who recently turned 70, the evidence is already in. Although she knows her condition has no cure, she's enjoying rides with Waylon. She felt confident enough to enter a local horse show recently—and together they



YOU WANT SOMEONE WHO CAN WALK IN THE RANGE OF 100 TO 500 METERS. THOSE UNABLE TO WALK 100 METERS MAY NOT BEABLE TO TOLERATE THE PROCEDURE." -Edmundo R. Rubio, M.D.

photo essay

A CALL TO ARMS: One of Carilion Clinic's six robots is docked to perform colorectal surgery at Carilion Roanoke Memorial Hospital (below). Dr. Daniel Tershak, chief of general surgery (right), uses the touch screen monitor to direct a resident sitting at the control console where to move the robot's instruments during a hernia repair at **Carilion Roanoke Community Hospita**







Appreciated by surgeons and patients alike for its less robotic program at Carilion Clinic continues to grow. by TIFFANY HOLLAND | photos by JARED LADIA



AT 1,200 POUNDS AND WITH FOUR ARMS, THE surgical robot squats like an intimidating, hulking figure in the operating room. But its most powerful tools are barely visible to the human eye-minuscule instruments so fine they can peel the skin off a grape.

During robotic surgery, the tiny tools are entirely controlled by a surgeon sitting at a console nearby. The robot's dexterity and three-dimensional cameras allow surgeons to feel as if they have their own heads and hands inside the surgical patient and are walking among organs, vessels, and incision points.

Robotic surgery has grown rapidly nationwide since it was introduced in 2000. Carilion Clinic has helped lead this trend as its own robotics program has ballooned to cover a breadth

invasive capabilities and faster recovery times, the surgical

of services and treatments since it began in the early aughts.

In 2004, Carilion had just one surgeon trained in robotic surgery. Now, more than 40 surgeons use Carilion's six robots in hospital operating rooms across the system. Carilion provides training for this in-demand offering through its residency programs and a minimally invasive surgery fellowship, and teams of surgical technicians are also now dedicated to the service.

Much of the demand has come from patients, who want the faster recovery times, reduced pain, and improved health outcomes the minimally invasive robotic procedures can deliver. As a result, Carilion has become one of the busiest robotic surgery centers on the East Coast.

While general surgical procedures are the ones most commonly performed with the Carilion robots, a variety of specialty-trained surgeons sit behind the robot's console to perform dozens of different procedures every week. A robot in Carilion Roanoke Memorial Hospital's operating room might spend one day removing multiple gallbladders or repairing hernias and the next treating ovarian or prostate cancer with its half-a-centimeter-sized hands.

"Robotic surgery's growth is really revolutionizing the way that we deliver surgical care," said Michael Nussbaum, M.D., senior vice president and chair of Surgery. "As our technological capabilities increase so do our operational standards. I will be excited to see how this program flourishes over the next decade."















HONEY, I SHRUNK THE SURGEON

A. Dr. Christopher Reynolds, a urologist, prepares the robot to perform a nephrectomy at Carilion New River Valley Medical Center. B. A robot visual pad and handles. C. At Carilion Roanoke Memorial Hospital, Dr. Paul Nickerson prepares a patient before docking the robot for a colorectal operation. D. One of the finger controls at the surgeon's console. E. Dr. Janet Osborne, a gynecologic oncologist, scrubs in for surgery. F. Dr. Kristin McCoy (left), a minimally invasive surgery fellow, and Dr. David Salzberg, a bariatric surgeon, sit at the robot's consoles. Dr. Salzberg, who performs the majority of his procedures robotically, uses dual consoles for training purposes. G. Dr. Nickerson monitors the surgical field before docking the robotic arms. H. A robot/patient positioning display panel. I. Clinical staff assist with instruments for the of his clinical team position the robot to begin an operation at Carilion Roanoke Community Hospital.

the art of medicine

BEST IN SHOW

The pandemic could halt in-person art shows, but it could not stifle medical students' revelry in art. **BY TIFFANY HOLLAND**

HE VIRGINIA TECH CARILION School of Medicine was unable to host its annual in-person art show last spring, but that was no reason to stop creating.

The school collaborated with the Taubman Museum of Art in Roanoke to bring an artistic activity to its students, faculty, and staff that would help brighten not only everyone's spirits, but also the school's hallways.

The school's community and culture team arranged a virtual "Paint Your Pet" activity. Participants submitted photos of their pets, and artists at the Taubman sketched the photos onto canvas with step-by-step instructions for the participants to paint them.

More than 50 submissions of dogs, cats, fish, and even a cow and a red panda arrived to spruce up the hallways.

"This was one of my favorite activities that has been offered to us," said Alex Goslow, a third-year student who painted a portrait of her 11-year-old pit bull, Raj. "The school does an amazing job of providing us opportunities to decompress, and that's one of the things I value most about this school. This is going in my bedroom. I've already planned it. When I was painting it, I chose the colors based on what I wanted to have in my room."

Participating in the art show was one of many ways the medical students unwind from their demanding schedules. The paintyour-pet initiative was part of the school's Creativity in Health Education program, an effort to expand the social, cultural, and humanistic awareness of the school's students, faculty, and staff by integrating the arts into their daily routines.

The program allows faculty and students to embrace the arts and understand the role that art can play in both education and the practice of medicine. Through art exhibits, the school is also able to involve community members in the life of the school.

"Art can enhance a person's adaption to illness as well as promote recovery," said David Trinkle, M.D., the school's associate dean for community and culture. "We hope the programs and shows that we feature at our school reinforce a holistic, patient-centered approach to health care that will benefit the students as well as the community as a whole."

REIGNING CATS AND DOGS

Medical student and faculty artists included: **A.** Kristina Gueco; **B.** Kritika Chugh; **C.** Claire Seo; **D.** Abby Ruffle; **E.** David Trinkle, M.D.; **F.** Stephanie Masters; **G.** Ariel Badger; **H.** Casey Engel; **I.** Miranda Gerrard; and **J.** Cameron Worden.











cheers for peers



Family Medicine

CAYLA BAKER, P.A.-C, and CHRISTINA GARDNER, P.A.-C, published a research paper, "A Diagnosis Suspected by Mechanism of Injury: Soft Tissue Infection Due to Aeronomas Hydrophilia and Enterobacter Asburiae Following Human Wastewater Exposure" in the February 2021 issue of the Journal of Urgent Care Medicine.



JOHN EPLING, M.D., medical director for wellness, authored a chapter in Primary

Care: Clinics in Office Practice's special issue focused on immunizations. The chapter is titled "Vaccine Policy in the United States."

chair of academic affairs and professional development for Family and Community Medicine, presented two webinars on gratitude for the American Medical Association's Emerging Topics in Professional Satisfaction and Practice Sustainability series.

MARK GREENAWALD, M.D., vice



Family Physicians advisory committee to help develop lifestyle medicine content. She also coauthored "Incorporating Lifestyle Medicine into Everyday Family Practice," a new guideline for the academy.

MARCUS SPEAKER, M.D., associate chief medical information officer, joined the Becker's

Healthcare Podcast to talk about the next evolution of virtual care and enterprise imaging.

Internal Medicine

CHINEKWU ANYANWU, M.D., Neurology, completed the 2020–2021 Women Leading in Neurology Program awarded by the American Academy of Neurology.

PAUL DALLAS, M.D., has earned Mastership in the American College of Physicians.

GREGORY DEHMER, M.D., Cardiology, was elected to the

American Board of Internal Medicine's Interventional Cardiology Approval Committee.

JASON FOERST, M.D., Cardiology, was the first provider in the country to enroll a patient in a groundbreaking heart failure clinical trial, "The CORCINCH-HF" study. The research allows Carilion to offer alternative options for patients with complex heart failure conditions.

ANTHONY LOSCHNER, M.D.,

Critical Care Medicine, gave a presentation titled "Artificial Intelligence in Pulmonary Medicine: The Rise of the Machines" at this year's CHEST meeting.

JAMES SCHMIDLEY, M.D., Neu-

rology, received the A.B. Baker Teacher Recognition Award from the American Academy of Neurology. This national honor recognizes outstanding dedication and commitment to teaching and helping train the next generation of doctors.

Obstetrics and Gynecology

JAMES CASEY, M.D., director of minimally invasive gynecologic surgery, was the recipient of the 2020 Rising Star Award given by the Society of Gynecologic Surgeons at its annual scientific meeting.

Orthopaedic Surgery



Congress in Joint Reconstruction's 9th Annual **Direct Anterior Approach Hip** Course. The four-part webinar series was titled "ICJR Insights:

Mastering the Direct Anterior Approach."

Dr. Moskal also was the guest co-editor for the Journal of Arthroplasty's COVID-19 Issue (Volume 35, Issue 7, 2020). He coauthored the editorial "Business Unusual: COVID-19 Ramifications for Arthroplasty," and was senior author on an article, "The Past, Present, and Future of Orthopaedic Education: Lessons Learned from the COVID-19 Pandemic."

coauthors included faculty members **DAVID HARTMAN**, M.D.; CHERI HARTMAN, PH.D.; ANITA KABLINGER, M.D.; and DR. TRESTMAN.

Posters at the American

cent Psychiatry's 2020 Virtual

Annual Meeting. The posters

on the Global Assessment of

of Youth Resiliency Checklist

in Child and Adolescent

Fellowship Programs

A team of Internal Medicine

Outpatients."

Residency and

Child and Adolescent Psychiatry, coauthored two posters accepted as New Research

Psychiatry

DAVID HARTMAN, M.D., has been named a fellow of the American Society of Addiction Medicine.

ROBERT TRESTMAN, M.D., PH.D.

chair of Psychiatry and Behavioral Medicine, was named chair of the American Hospital Association's Behavioral Health Services Council. He also presented at the association's staff meeting on "Health Systems Behavioral Health Transformations During and After the Pandemic."

Several members of Psychiatry and Behavioral Medicine published an article in the January issue of BMC Psychiatry titled "Systematic Content Analysis of Patient Evaluations of START NOW Psychotherapy Reveals Practical Strategies for Improving the Treatment of Opioid Use Disorder." Authors included eight recent graduates of the Virginia Tech Carilion School of Medicine: ALBERT YI-QUE **TRUONG, M.D.; BRIAN FABIAN** SAWAY, M.D.; MALEK BOUZA-HER, M.D.; MUSTAFA NAWROZ RASHEED, M.D.; SANAZ MONJA-**ZEB, M.D.; SOLEILLE DOROTHY** EVEREST, M.D.; and SUSAN LINDA GIAMPALMO, M.D. Other

residents—JAREK MARVA, D.O.; KAT MUSTAFA, D.O.; and IAN RICHARDSON, D.O.-won the Virginia chapter of the American College of Physicians' medical jeopardy competition this year. The team members

Provider Excellence Awards

The Carilion Clinic Provider Excellence Awards recognize providers who demonstrate dedication and exceptional care to patients, families, staff, and fellow providers. Recipients are nominated by their colleagues. This year's recipients were:

JENNIFER BENNETT GRUBE, DEETTA RAY, D.N.P., Cardiology, who received M.D., Hospitalist Medicine, and SORIN SCARLATESCU, the award for Advanced M.D., Hospitalist Medicine, Clinical Practitioners. who received the award for Physicians.

also represented the Commonwealth of Virginia at the college's national competition.

Surgery

ERIC VANCE, M.D., Academy of Child and Adoles-

are titled "Impact of COVID-19 Functioning Scores" and "Effect

Score on Course of Depression

TRAVIS REEVES, M.D., coauthored "Incidence of Fistula Formation and Velopharyngeal Insufficiency in Early Versus Standard Cleft Palate Repair," which was published in the Journal of Craniofacial Surgery in June.

BRYAN COLLIER, D.O., chief of Acute Care Surgery, along with JENNIFER BATH, R.N., published an invited commentary on "The Effects of a Novel Mindfulness-Based Intervention on Nurses' State Mindfulness and Patient Satisfaction in the Emergency Department" in the Journal of Emergency Nursing.

Other

DANIEL FREEMAN, R.N., director of trauma services and facility organ donation coordinator for Carilion Roanoke Memorial Hospital, received the Governor's Annual EMS Award.

LYDIA HIGGS, L.C.G.C., was appointed by Virginia Gov. Ralph Northam to serve on the Advisory Board on Genetic Counseling.



MARIA HIRSCH, C.R.N.A., a member of a research team looking at the impact of the

COVID-19 pandemic on certified registered nurse anesthetists, collaborated on a published study, "From the Operating Room to the Front Lines: Shared Experiences of Nurse Anesthetists During the Coronavirus Pandemic," in the April 2021 issue of the American Association of Nurse Anesthetists Journal.

PATRICE M. WEISS, M.D., chief medical officer and executive vice president, and SARAH **HENRICKSON PARKER, PH.D.,** director of human factors research, were selected by Vizient, a health care performance improvement company, to present "Human Centered Design Approach to COVID PPE Challenges" at the company's November in-person summit in Las Vegas.

BADR RATNAKARAN, M.B.B.S.,

Psychiatry resident, who received the award for **Residents and Fellows.**



ROCKET MAN

A serial entrepreneur now serves as ground control for helping others take off. **BY VICTOR IANNELLO. Sc.D.**

T WAS FEBRUARY 1992. I had just interviewed for a position as the director of development for a small technology company in Roanoke, and I had already fallen in love with the area. Having grown up in metropolitan New York, attended school in Boston, completed a postdoc in France, and lived

two children, which turned into three children several years after we arrived.

I had enjoyed the challenge of my job in New Hampshire, where I served as a principal investigator for engineering research programs, but I was becoming frustrated. I realized that developing products was my true passion, so I took a chance on the small company in Roanoke.

Although the gamble on Roanoke ultimately was a win, the gamble on the company was not. Within six months, I decided to leave the company and start my

own. With few savings, a family, and a mortgage payment, I didn't have much of a runway. After several months of generating new ideas, submitting proposals, and having sleepless nights, some of the proposals were accepted. I now had contracts with the Department of Defense, NASA, and local industry. I began to hire, and I slept better.

What started as me working alone and out of my basement soon turned into two companies and eventually 100 employees. We were able to attract capital investment, which we used to develop more products, and we expanded our customer base to companies around the world. I then sold the smaller company, and after the acquisition of the larger company by a multibillion-dollar publicly traded company, I stayed on for over a year to help integrate our business unit with the parent company.

During that time, I realized I missed the excitement and autonomy of a small company, and I left to pursue other opportunities. Since then, I've been part of a group of local entrepreneurs who have used our experiences to help build out the emerging innovation ecosystem of this region. We've mentored founders, in New Hampshire, I believed Roanoke would be a great helped organize local sources of investment capital, place for my wife, Chris, and me to live and to raise our and supported technology transfer from Virginia Tech.

Carilion has a special place in the ecosystem, and I've had the opportunity to help its leaders structure a robust program for identifying, protecting, testing, and commercializing the intellectual property of clinicians and staff, as well as form partnerships with other early-stage health care companies.

Many of these companies need to conduct clinical trials to validate products or receive regulatory approval. Carilion may serve as a beta test site before a product is broadly marketed. Collaborators also benefit from clinical ad-

vice—which is especially valuable for companies whose founders are not health care practitioners-and business and regulatory experience in the health care field.

Beyond the promise of improving health care, we're seeing a health science and technology business cluster emerge in our region. I now have a management role with one of those startups, which is developing nonopioid drugs for the management of chronic pain.

As I work with startups in the region, I'm frequently reminded of the fear and the exhilaration of growing a small company. I'll always be a strong advocate for aspiring entrepreneurs, whom I admire tremendously.

Victor Iannello, Sc.D., is chief executive officer of Chorda Pharma, an early-stage pharmaceutical company. He earned his doctorate in nuclear engineering at the Massachusetts Institute of Technology.



Cynthia W. Choate, M.D. Cardiothoracic Surgery CarilionClinic.org/CVI

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online exclusives



Triple Threat

"The selection of Virginia's Blue Ridge region as an IRONMAN host was a remarkable honor for everyone who calls our region home," says Dr. Thomas "T.K." Miller, vice chair of Orthopaedics.



Balloon Trial

Cr. Biraj M. Patel, a national principal investigator for a balloon-guided catheter trial for use in stroke-patient surgery, is one of nearly 200 Carilion clinicians involved in clinical trials.



Under a New Roof Carilion Children's Tanglewood Center, home to more than a dozen outpatient pediatric subspecialty practices, officially opened in

early October.

Please visit us at CarilionClinic.org/carilionmedicine. If you would like a complimentary subscription to Carilion Medicine, please email us at CarilionMedicine@carilionclinic.org.