Joint Department of

BIOMEDICAL ENGINEERING

UNC CHAPEL HILL

NC STATE UNIVERSITY

SPRING / SUMMER 2021

Michael Bass, D.D.S., uses **an AerFrame mask frame** in his Apex, NC, office. Learn more about this BME invention on **page 6**.

IN THIS ISSUE

LETTER FROM THE CHAIR

Paul Dayton

DEAR BME ALUMNI AND FRIENDS:

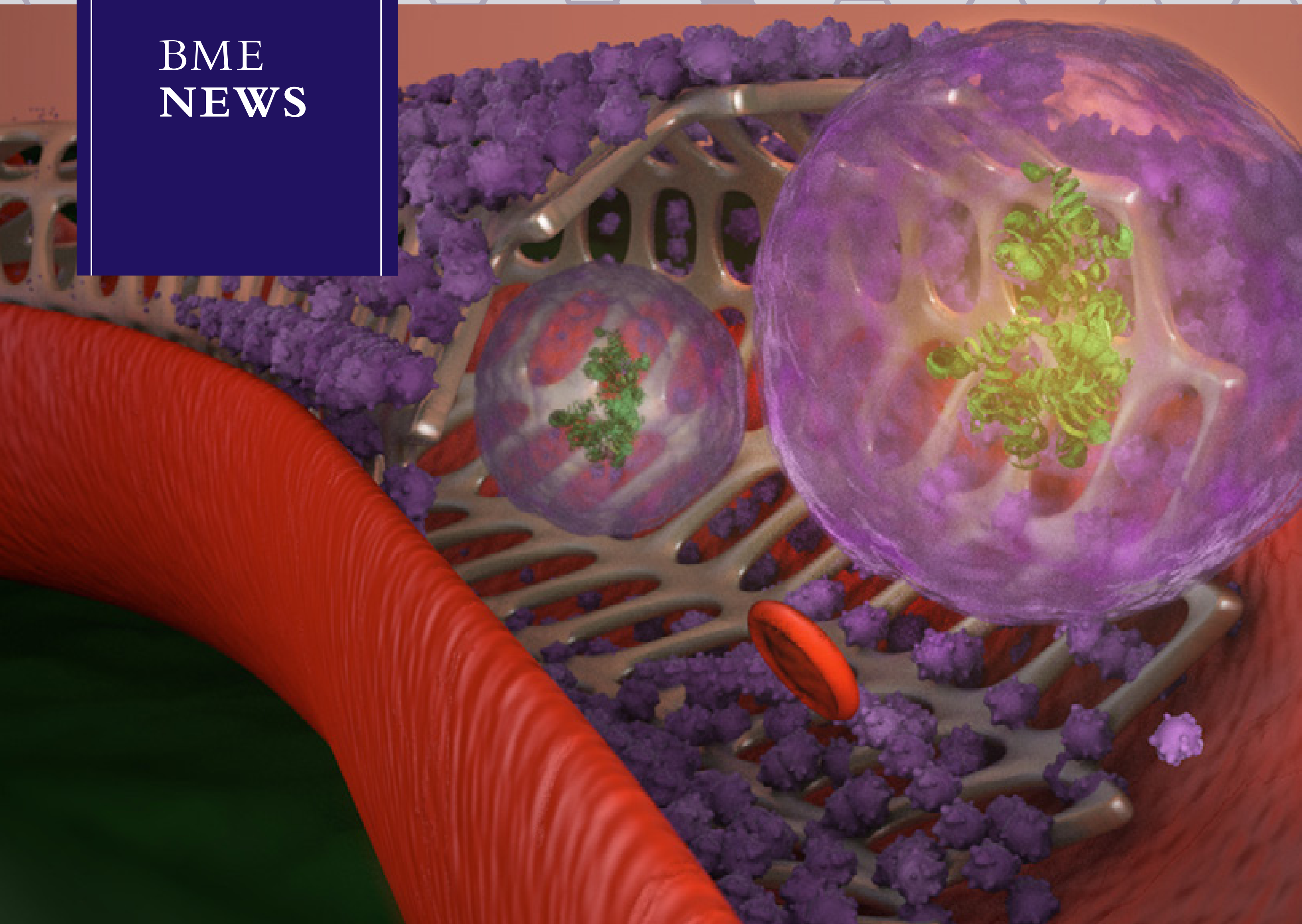
"Build back better" is the mission statement of the U.S. Executive Branch's new administration. Considering the statement's merits, it occurs to me that not only does it suit the historical moment we find ourselves in, but it is also the eternal mission of biomedical engineers. If biology's engineering is damaged, deformed or otherwise inadequate, then biomedical engineers strive to build back better. As one can see in the following articles, this certainly is what the UNC / NC State Joint Department of Biomedical Engineering has labored to do in its efforts to both prevent and remediate COVID-19 infections. We are happy to report in these pages the emerging results of our efforts include the ability to rapidly innovate remediations for a global health crisis, nimbly educate students in various modes demanded by circumstances, and creatively conduct world-class research in the midst of a pandemic.

As you read on you will find stories of our department's undergraduate and graduate students receiving prestigious scholarships and national or international awards. There are also reports of our alumni cited and honored for leadership in their areas of expertise. Further, look for accounts of distinguished Joint Department faculty members being inducted to some of biomedical engineering's most prestigious organizations, such as the American Institute for Medical and Biological Engineering (AIMBE) and the National Academy of Inventors (NAI). This well-deserved recognition is emblematic of how the department's faculty, staff and students adapted to work-from-home, social distancing and decreased lab time to succeed within these constraints. Examples abound, such as the design professor working in his garage with a 3-D printer and virtual collaborators producing a frame that when worn over a face mask substantially upgrades protection. Or not one member of the department contracting COVID-19 from exposure in the lab. Or the use of freed time to publish and seek research funding — the department's success with this last resulting in a 20-percent increase in sponsored research funding to a record cumulative annual research award budget of nearly $26 million. This unprecedented financial support will further propel the status of the BME department, ranked 6th nationally (3rd for public universities) in National Institutes of Health funding in 2020 (reported by Blue Ridge Institute of Biomedical Research, Feb. 2021), and puts it in an excellent position to robustly restore and then expand laboratory productivity as 2021 progresses toward business as usual.

As I write this, indications are for the Joint Department to return to full operations better and stronger than ever. Faculty and staff members are largely vaccinated already, with many students receiving their shots now. This past week, both of our home universities announced their plans to start the Fall 2021 semester in a near-normal, in-person format. Our laboratories are on track to reestablish 100-percent capacity in the foreseeable future. Ultimately, as the demands of the crisis to build back better recede, the Joint Department of Biomedical Engineering will refocus on its fundamental mission: **to unite engineering and medicine to improve lives**. I assess we are well set to do so.

Sincerely,

Paul A. Dayton, Ph.D.
William R. Kenan Jr. Professor and Interim Chair
UNC / NC State Joint Department of Biomedical Engineering

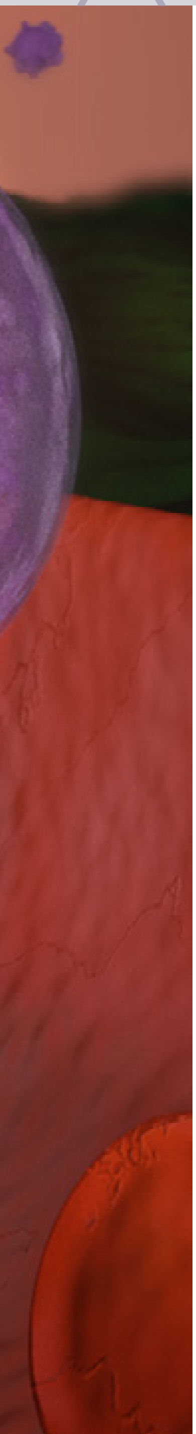


Reopen and regenerate: Exosome-coated stent **heals vascular injury, repairs damaged tissue**

By Tracey Peake, NC State News Services

RESEARCHERS FROM NC STATE have developed an exosome-coated stent with a "smart-release" trigger that could both prevent reopened blood vessels from narrowing and deliver regenerative stem cell-derived therapy to blood-starved, or ischemic, tissue.

Angioplasty — a procedure that opens blocked arteries — often involves placing a metal stent to reinforce arterial walls and prevent them from collapsing once the blockage is removed. However, the stent's placement usually causes some injury to the blood vessel wall, which stimulates smooth muscle cells to proliferate and migrate to the site in an attempt to repair the injury. The result is restenosis: a re-narrowing of the blood vessel previously opened by angioplasty.



"The inflammatory response that stents cause can decrease their benefit," says Ke Cheng, corresponding author of the research. "Ideally, if we could stop smooth muscle cells from over-reacting and proliferating, but recruit endothelial cells to cover the stent, it would mitigate the inflammatory response and prevent restenosis." Cheng is the Randall B. Terry Jr. Distinguished Professor in Regenerative Medicine at NC State and a professor in the Joint Department.

"... A patient wouldn't need additional procedures for regenerative therapy after the stent is in place."

Ke Cheng

There are drug-eluting stents currently in use coated with drugs that discourage cell proliferation, but these anti-proliferative drugs also delay stent coverage by endothelial cells — which are the cells healthcare providers want to coat the stent.

To solve this problem, Cheng and his team developed a stent coating composed of exosomes. Exosomes are nanometer-sized sacs secreted by most cell types (in this case mesenchymal stem cells). The purpose of the exosome coating is to provide two beneficial effects. The first benefit is to "camouflage" the stent from smooth muscle cells and the body's immune system to avoid their overreaction. The second benefit is to promote coverage of the stent by endothelial cells and, in the case of injury, to promote tissue repair. As exosomes are composed of materials not much different from cell membranes both benefits were achieved.

To prevent premature depletion of the therapy, the stent releases exosomes when it encounters reactive oxygen species (ROS) — which are more prevalent during an inflammatory response.

"Think of it as a smart release function for the exosomes," Cheng says. "Ischemic reperfusion injuries, which occur when blood flow is diminished and then reestablished, create a lot of ROS. Let's say the heart is damaged by ischemia. The enhanced ROS will trigger the release of the exosomes on the stent, and regenerative therapy will travel through the blood vessel to the site of the injury."

The research team performed in vitro testing to ensure biocompatibility and to test the release mechanism. They found that in the presence of ROS, the exosomes released up to 60 percent of their secretions within 48 hours post-injury.

In a rat model of ischemic injury, the researchers compared their exosome-eluting stent (EES) to both a bare metal stent (BMS) and a drug-eluting stent (DES). They found that in comparison to the BMS, their stent performed better in both decreasing stenosis and promoting endothelial coverage. While the DES performed similarly to the EES in preventing restenosis, the EES was less injurious to the vessel wall and had better endothelial coverage overall. In addition, the exosomes released from EES promoted muscle regeneration in rats with hind limb ischemia. The researchers plan to test the stent in a large animal model with an eye toward eventual clinical trials.

"This bioactive stent promotes vascular healing and ischemic repair, and a patient wouldn't need additional procedures for regenerative therapy after the stent is in place," Cheng says. "The stent is the perfect carrier for exosomes, and the exosomes make the stent safer and more potent in tissue repair."

The research was supported by the National Institutes of Health and the American Heart Association. NC State postdoctoral research scholars Shiqi Hu and Zhenhua Li are co-first authors. •

TINY BUBBLES: Taking on cancer at a microscopic level

UNC Lineberger Comprehensive Cancer Center

Paul Dayton

MICROBUBBLES ARE NOT what form when you run your hot tub jets at high speed. Rather, they're an artificial construct that consists of gas surrounded by a thin, fatty shell that ranges from one to 10 thousandths of a millimeter in diameter. These bubbles are one of the more exciting tools, when married with ultrasound, that are helping revolutionize cancer research and therapy.

At the forefront of that research is BME professor and interim chair Paul Dayton, who is also involved in UNC's Lineberger Comprehensive Cancer Center. The Joint Department is a unique and important association that boosts collaborative research efforts across North Carolina by bringing medical and engineering expertise together to solve problems in health care.

"Our workplace is called the Non-Invasive Functional Imaging and Targeted Therapeutics Lab because the two go hand-in-hand, especially since ultrasound and microbubbles are used in all of our projects," Dayton says. "Ultrasound is a really unique modality because it is both highly effective for imaging and for therapy, as we can do either independently as well as using imaging to guide therapy, the latter being crucially important for many non-invasive, targeted, non-pharmaceutical therapies."

Advancements in ultrasound technology

Ultrasound is an imaging technique that has been in use for the past half century. While major medical imaging tools, such as MRI, are quite large and are getting more expensive, ultrasound is getting smaller and cheaper. Many former limitations of ultrasound technology were related to electronics, but with the advances in integrated circuits and microchips, ultrasound systems are now as small as a cell phone, and they don't cost much more than a cell phone, either.

Currently, ultrasound is mainly used to evaluate anatomy and tissue differences, such as observing suspicious lesions to see if they appear cancerous. It is also used to image blood flow patterns which might suggest disease or pathology, or lack thereof. With the latest advancements, Dayton's lab is exploring new ways to use ultrasound to look in great detail at the tiny blood vessels, or microvasculature, that course throughout the body.

"If there was a technique available that could image microvascular properties, it could tell physicians a lot about disease status," says Dayton. "So, we are working on techniques to enable ultrasound to visualize small blood vessels, and these techniques involve contrast agents, primarily microbubbles, that flow through, and thus highlight, the microvasculature."

Microbubbles in cancer research

Engineered microbubbles, which have been around for more than 30 years, scatter sound so that they are easy to detect with ultrasound. Dayton's lab needs bubbles that can last up to five minutes for imaging projects, so they use fluorocarbon gas, which is inert. For treatment applications, however, they use a gas that tumors are short on — oxygen — which exits the bubble and can flow into a tumor and make it more susceptible to treatment by radiation.

Recently, microbubbles received expanded approval from the U.S. Food and Drug Administration for visualizing the liver to help characterize liver lesions. Most crucially in the treatment realm, microbubbles can cause a range of biological effects. At low ultrasound intensities, such as those used for contrast ultrasound imaging, biological changes are believed to be very minimal, with adverse effects being less than other imaging contrast agents. However, at high ultrasound energies, microbubbles can have a range of effects, such as changing the permeability of blood vessels, enhancing immune response, and even destroying tissue at high intensity ranges. While these effects are not desirable for diagnostic imaging, they can be helpful therapeutically if used in a controlled fashion, notes Dayton.

Better treatments for cancer are the ultimate goal for Dayton's lab. For example, immunotherapies haven't been used extensively or effectively against pancreatic cancer, but it might be possible that stimulating the immune system with microbubbles could be effective. However, there is much work to be done to make this a reality. "We are still trying to understand exactly what might be going on when trying to treat cancer with microbubbles. One hypothesis is that ultrasound using microbubbles induces mechanical agitation of diseased cells, leading to an increase in the release of antigens that could stimulate immune responses to attack cancer," he says.

"One hypothesis is that ultrasound using microbubbles induces mechanical agitation of diseased cells, leading to an increase in the release of antigens that could stimulate immune responses to attack cancer."

Paul Dayton

Developing targeted therapies

Dayton's lab also works on targeted therapies. They are developing delivery vehicles that can be activated by ultrasound to release a drug to the target site. The goal is that local delivery of a drug will have improved efficacy to the diseased tissue and reduced systemic effects. Additionally, they hope to use ultrasound to modify the tissue itself. One example would be locally modulating the blood / brain barrier to allow systemically circulating drugs to cross the barrier and treat a brain disease.

Looking forward

So, what's next? Dayton's lab is working with two local companies he co-founded to advance his research: SonoVol is developing and selling advanced ultrasound imaging systems; Triangle Biotechnology is developing reagents for ultrasound applications in genetic and genomic analysis.

Ultimately, though, low cost, portability, safety and the improved image quality of new ultrasound devices are all reasons why Dayton thinks ultrasound married to microbubble use is going to play an increasingly important role in the future of cancer research and public health.

Dayton said the success of translating laboratory discoveries into potential clinical advances speaks to the collaborative spirit of UNC Lineberger and UNC Health faculty. "We are actively developing lots of different technologies, and if we can get some of them into the clinic to save lives, that would be huge," he says. •

Building smarter so we can **breathe easier**

By Shellie Edge, Innovate Carolina | Photos by Kevin Greenhill and Mary Lide Parker

INNOVATION IS FLUID, and the art of tapping into the right resources and support at the right time is crucial, particularly during a pandemic. Devin Hubbard, teaching associate professor in BME and lead design engineer at the North Carolina Translational and Clinical Sciences Institute (NC TraCS), has perfected the art of using resources offered by UNC-Chapel Hill's Innovate Carolina network to find quick answers to pressing problems. In response to the increased need for personal protective equipment (PPE) during the COVID-19 pandemic, Hubbard and his team launched Aerem Innovations, a technology company designing solutions for health care and commercial applications. The company is producing the AerFrame, a mask frame device designed to improve the comfort and effectiveness of existing face masks.

If not for his strong, diverse connections across the University's innovation and entrepreneurship (I&E) network, Hubbard may not have been able to build his company as quickly as he did. He launched Aerem Innovations in July 2020, just a few months after initially exploring his idea for the mask frame in spring 2020.

"Collaboration and access to diverse resources and thinkers is always vital, but it is absolutely necessary…

especially when looking to solve a problem that didn't exist a year ago," says Hubbard. "The ability to have access to so many diverse resources and connections made this sprint to market possible."

Connecting across campus to speed innovation

As a professor, researcher and entrepreneur, Hubbard is plugged into the many I&E tools and programs available on campus. When his team was ready to launch Aerem Innovations, his resourceful approach gave him instant access to experts, which led to quick connections and cross-campus collaborations with Innovate Carolina's KickStart Venture Services and Office of Technology Commercialization teams, Carolina Research Ventures, NC State University Nonwovens Institute, UNC Healthcare, Center for Environmental Medicine and Asthma, the Joint Department and the FastTraCS team.

KickStart Venture Services (KVS), a startup services program and accelerator within UNC-Chapel Hill's Innovate Carolina office, offers a variety of services to faculty-founded ventures based on intellectual property. These include the coaching, advisement and connections it provides during normal periods to pandemic-specific support like helping companies pivot existing life science technologies toward COVID-19, write proposals for COVID-related federal grants and plan for future physical space needs.

"I teach in a very entrepreneurial style, and I like to cultivate the entrepreneurial spirit in my classroom," says Hubbard. "We definitely took advantage of KickStart's connections. Through the network, we've made a lot of great connections that have helped enable our progress to where we are now."

Aerem Innovations participated in the Venture Catalyst Program, an initiative from Innovate Carolina and KVS that allows leaders of UNC-affiliated startups, serial entrepreneur coaches and talented graduate students to converge and collaborate. The program includes two connected opportunities. The first is a coaching session module that brings together teams of serial entrepreneurs who use pitch-based coaching to provide expert advice, connections and mentorship. The second is a fellows program, which offers educational and experiential learning opportunities to uncover market opportunities and solve business challenges.

When identifying companies to participate in the program, the Venture Catalyst Program team knew Hubbard's company would be a perfect fit.

"As one of Kickstart's emerging ventures from 2020, Aerem Innovations was selected for participation in the Venture Catalyst Program given their impressive accelerated commercialization timeframe, along with their mission to support vital public health needs created by the COVID-19 pandemic," says Judy Prasad, operations and program manager at KickStart Venture Services. "As the company continues to meet critical milestones, we foresee the resources provided by our program as integral to their product development strategy."

Kickstart helps early-stage companies meet commercial milestones either on the technical side (prototype development, animal studies) or on the business side (regulatory pathway, freedom to operate).

The UNC Office of Technology Commercialization (OTC) provided support by helping Aerem Innovations gain a Carolina Express license, which streamlines and speeds the path for UNC-Chapel Hill faculty, student or staff startup founders to translate new discoveries into useful products.

"Given the nature of the device that was developed by Devin (Hubbard) and his co-inventors, PPE to address the pandemic-related N95 mask shortage, there was a sense of urgency to move forward as quickly as possible so this product could address the shortage," says Matt Howe, a commercialization manager with OTC. "We worked together to quickly protect the intellectual property as well as quickly license the IP through a Carolina Express License so that frame manufacturing could begin. The benefit of a frame like this was clear from the start — addressing N95 mask shortages, while improving the efficiency of cloth and surgical masks that are frequently worn in daily life."

The new company also worked with the Carolina Research Ventures Program, an early-stage investment fund that helps provide critical discovery and development capital and aims to unlock the potential of UNC technologies and advance the commercialization of these technologies by providing early-stage capital and industry expertise. Hubbard and his team tapped into the deep expertise and connections provided by CRV to advance their business and go-to-market strategy.

Building a team within the Carolina entrepreneurial community

The various innovation support groups and programs that Hubbard worked with across campus also helped him to build his company's team, which is comprised of industry experts as well as Carolina graduate and undergraduate students. The Aerem Innovations team — a small group of eager, talented innovators — was ready to meet the unknown challenges of building the startup during a pandemic, while stepping into leadership roles.

"Entrepreneurship is a really powerful tool to enable leadership diversity, empowering those that may not normally be expected to be leaders in a company," says Hubbard. "I want everyone on my team to be leaders in the future if they're not already. It's important to me that I get a chance to develop that with my team."

As it turns out, Aerem Innovations is a new venture that's charting new territory for how Carolina faculty members and students work together on building companies.

"This is the first time in the history of the University of North Carolina that a company has been co-founded by a faculty member and an undergraduate at the same department," says Hubbard. "We take that as a point of pride."

Ethan Smith, head of research and development for the company, is a third-year undergraduate in BME and is responsible for the CAD modeling, design iteration and product evaluation at the company.

"It's been a crazy experience from the beginning, primarily due to life during a pandemic but also because we're trying to do our part in alleviating some of those adverse effects," says Smith. "My role in R&D is something I'm pretty familiar with as I've been working with CAD for a while now, but the biomedical side is new and an area I've wanted to work in. I came to UNC to get more experience in medical-oriented research and projects through the BME department, so this opportunity was a perfect fit. I may be on the younger side for the position I have in our startup, but I've felt well prepared from my previous experiences and have expanded my skill set through working with the Aerem Innovations team."

Co-founder Nicole Wiley, head of regulatory affairs for the company, is also a prototype and design engineer at FastTraCS. FastTraCS is a small group of biomedical engineers within NC TraCS who support UNC Health physicians, nurses and staff by identifying problems in clinical settings and creating innovative, technological solutions.

"I believe we've engineered a novel device that will help many people, so there was no hesitation when taking on the role and its responsibilities in order to ensure Aerem Innovations succeeds," says Wiley. "The team at Aerem is so talented and supportive of one another that success in not just my role but everyone's role is almost guaranteed."

Hubbard's initial work at the beginning of the pandemic through the BME department allowed the team many immediate advantages, including product development and rapid feedback on the device designs as well as materials. The department has played a significant role in responding to COVID-19.

"One of the huge advantages of having deep connections at NC State is that we can call up anyone over at the College of Textiles, the College of Engineering or the College of Veterinary Medicine," says Hubbard. "We can leverage resources from both campuses, which puts us in a pretty unique and powerful position." •

For more information, visit aereminnovations.com

PERICARDIAL INJECTION EFFECTIVE, LESS INVASIVE WAY TO GET **REGENERATIVE THERAPIES TO HEART**

By Tracey Peake, NC State News Services

INJECTING HYDROGELS containing stem cell or exosome therapeutics directly into the pericardial cavity could be a less invasive, less costly and more effective means of treating cardiac injury, according to new research from BME.

Stem cell therapy holds promise as a way to treat cardiac injury, but delivering the therapy directly to the site of the injury and keeping it in place long enough to be effective are ongoing challenges. Even cardiac patches, which can be positioned directly over the site of the injury, have drawbacks in that they require invasive surgical methods for placement.

"We wanted a less invasive way to get therapeutics to the injury site," says Ke Cheng, Randall B. Terry Jr. Distinguished Professor in Regenerative Medicine at NC State's Department of Molecular Biomedical Sciences and professor in BME. "Using the pericardial cavity as a natural 'mold' could allow us to create cardiac patches — at the site of injury — from hydrogels containing therapeutics."

In a proof-of-concept study, Cheng and colleagues from NC State and UNC-Chapel Hill looked at two different types of hydrogels — one naturally derived and one synthetic — and two different stem cell-derived therapeutics in mouse and rat models of heart attack. The therapeutics were delivered via intrapericardial (iPC) injection.

Via fluorescent imaging the researchers were able to see that the hydrogel spread out to form a cardiac patch in the pericardial cavity. They also confirmed that the stem cell or exosome therapeutics can be released into the myocardium, leading to reduced cell death and improved cardiac function compared to animals in the group who received only the hydrogel without therapeutics.

The team then turned to a pig model to test the procedure's safety and feasibility. They delivered the iPC injections using a minimally invasive procedure that required only two small incisions, then monitored the pigs for adverse effects. They found no breathing complications, pericardial inflammation or changes in blood chemistry up to three days post-procedure.

"Our hope is that this method of drug delivery to the heart will result in less invasive, less costly procedures with higher therapeutic efficacy," Cheng says. "Our early results are promising — the method is safe and generates a higher retention rate of therapeutics than those currently in use. Next, we will perform additional preclinical studies in large animals to further test the safety and efficacy of this therapy, before we can start a clinical trial."

"I anticipate in a clinical setting in the future, iPC injection could be performed with pericardial access similar to the LARIAT procedure. In that regard, only one small incision under local anesthesia is needed on the patient's chest wall," says Joe Rossi, associate professor in the division of cardiology at UNC-Chapel Hill and co-author of the paper.

The research was supported by the National Institutes of Health and the American Heart Association. Thomas Caranasos, director of adult cardiac surgery at UNC-Chapel Hill, also contributed to the work. •

New tech aims to **tackle 'disseminated intravascular coagulation'** blood disorder

By Matt Shipman, NC State News Services

> **"Our goal is to find a clinical intervention that addresses this dilemma. And our results so far are promising."**
>
> Ashley Brown

RESEARCHERS HAVE DEVELOPED a new tool for addressing disseminated intravascular coagulation (DIC) — a blood disorder that proves fatal in many patients. The technology has not yet entered clinical trials, but in vivo studies using rat models and in vitro models using blood from DIC patients highlight the tech's potential.

"DIC basically causes too much clotting and too much bleeding at the same time," says Ashley Brown, corresponding author of a paper on the work. "Small blood clots can form throughout the circulatory system, often causing organ damage. And because this taxes the body's supply of clotting factors, patients also experience excess bleeding. Depending on the severity of DIC, between 40 percent and 78 percent of patients with DIC die.

"DIC is associated with a number of other conditions, such as sepsis and cancer — and it is very difficult to treat," adds Brown, who is an assistant professor in the Joint Department. "Doctors often focus on trying to treat underlying condition. But if the DIC is bad, doctors face a dilemma: if they treat the bleeding, they'll make the clotting worse; if they treat the clotting, they'll make the bleeding worse. Our goal is to find a clinical intervention that addresses this dilemma. And our results so far are promising."

Brown and her collaborators have developed a technique that makes use of nanogel spheres. The spheres are engineered to bind to a protein called fibrin, which is the main protein found in blood clots. As a result, the spheres will travel through the bloodstream until they reach a blood clot, at which point they will stick to the fibrin in the clot.

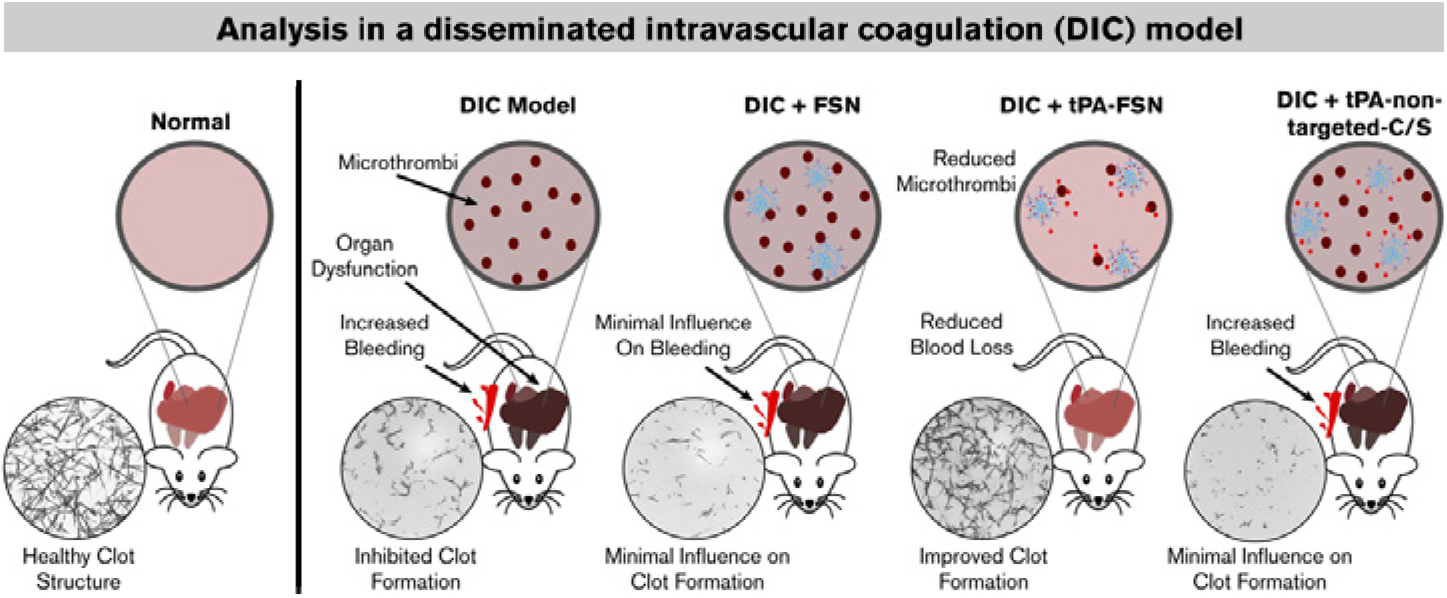
These nanospheres are about 250 nanometers in diameter and are porous. In this case, the researchers have loaded the nanospheres with tissue-type plasminogen activator (tPA) — a drug that breaks down clots.

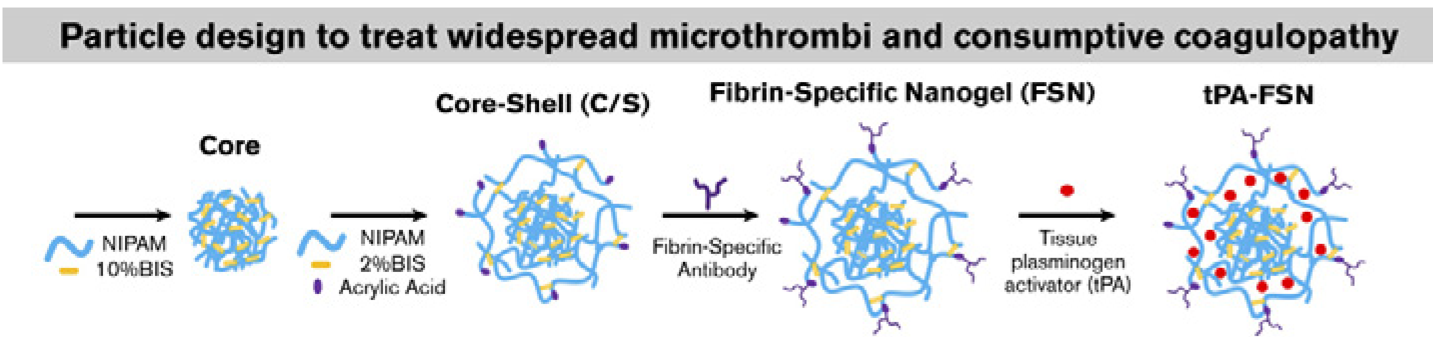
"Based on in vitro testing and testing in a rat model, we found that where you have pre-formed clots (not active bleeding) that the tPA spheres stick to fibrin and break up the clots," says Emily Mihalko, first author of the paper and a Ph.D. candidate in the Joint Department. "Breaking up these clots also releases other clot constituents, such as platelets, which evidence suggests may be re-recruited by the body at active clotting sites (i.e., places where there was actually bleeding)."

In one study, the researchers evaluated the use of the tPA and targeted nanospheres in a rat model involving DIC that stems from sepsis. In that study, the researchers found that delivering tPA via the targeted nanospheres eliminated 91 and 93 percent of the clots found in the heart and lung respectively, and 77 percent of the clots found in the liver and kidneys.

"We also did in vitro testing using blood plasma from patients with DIC, and found similarly promising results," Brown says.

"We are currently exploring different dosages in the animal model," Mihalko says. "And are doing work to better understand how the particles are distributed in the





body and how long it takes before they are cleared by the body — which is important information for addressing safety considerations prior to any clinical trials."

The researchers note that it is too early to put a price tag on any potential treatments that make use of the technology. However, they note that the targeted nanogels mean that treatment would likely involve using smaller doses of tPA than are currently in clinical use.

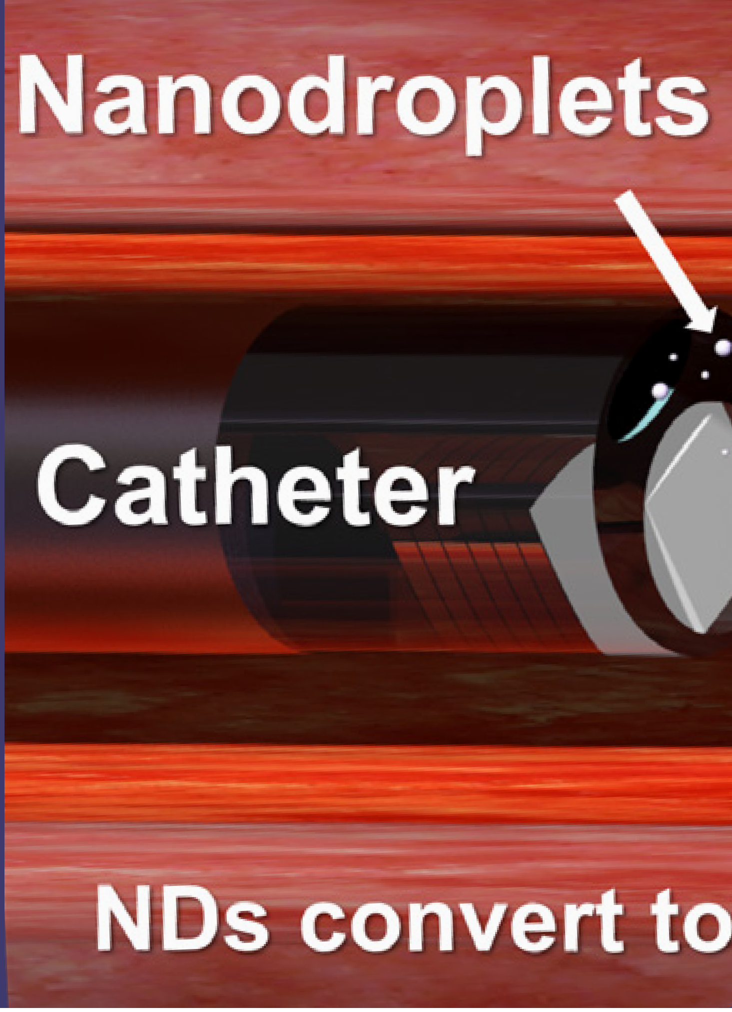
"The cost of creating the targeted nanospheres would likely offset the savings from using less tPA, so we suspect it may be comparable to the cost of conventional tPA therapies," Brown says.

The paper was co-authored by Megan Sandry, a former undergraduate in the Joint Department; Nicholas Mininni, an undergraduate in the Joint Department; Kimberly Nellenbach and Halston Deal, Ph.D. students in the Joint Department; Michael Daniele, an associate professor of electrical and computer engineering at NC State; Kamrouz Ghadimi, an associate professor of anesthesiology and critical care at Duke University; and Jerrold Levy, professor of anesthesiology and critical care at Duke University.

The work was done with support from the National Science Foundation; the National Heart, Lung, and Blood Institute; the North Carolina Biotechnology Center; the American Heart Association; the U.S. Department of Defense; and the National Institute of General Medical Sciences.

Brown is the founder of SelSym Biotech, Inc., which focuses on developing injectable hemostatic materials. Levy serves on advisory boards for Instrumentation Labs, Octapharma and Merck. •

Nanodroplets and ultrasound 'drills' prove effective at **tackling tough blood clots**



A NEW TECHNIQUE for eliminating particularly tough blood clots uses engineered nanodroplets and an ultrasound "drill" to break up the clots from the inside out. The technique has not yet gone through clinical testing. In vitro testing has shown promising results.

Specifically, the new approach is designed to treat retracted blood clots, which form over extended periods of time and are especially dense. These clots are particularly difficult to treat because they are less porous than other clots, making it hard for drugs that dissolve blood clots to penetrate into the clot.

The new technique has two key components: the nanodroplets and the ultrasound drill.

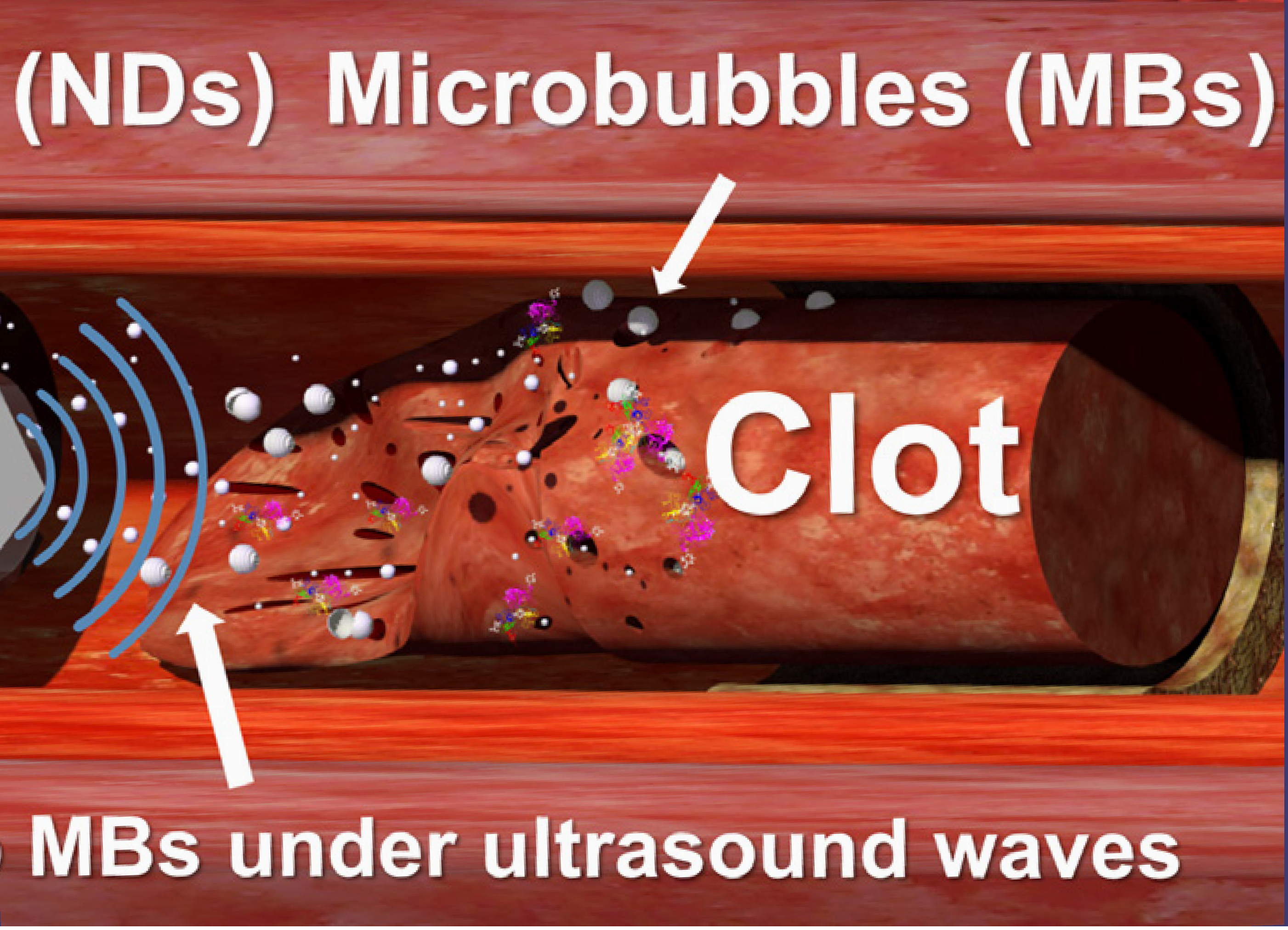
The nanodroplets consist of tiny lipid spheres that are filled with liquid perfluorocarbons (PFCs). Specifically, the nanodroplets are filled with low-boiling-point PFCs, which means that a small amount of ultrasound energy will cause the liquid to convert into gas. As they convert into a gas, the PFCs expand rapidly, vaporizing the nanodroplets and forming microscopic bubbles.

"We introduce nanodroplets to the site of the clot, and because the nanodroplets are so small, they are able to penetrate and convert to microbubbles within the clots when they are exposed to ultrasound," says Leela Goel, first author of a paper on the work. Goel is a Ph.D. student in BME.

After the microbubbles form within the clots, the continued exposure of the clots to ultrasound oscillates the microbubbles. The rapid vibration of the microbubbles causes them to behave like tiny jackhammers, disrupting the clot's physical structure, and helping to dissolve the clots. This vibration also creates larger holes in the clot mass that allow blood borne anti-clotting drugs to penetrate deep into the clot and further break it down.

The technique is made possible by the ultrasound drill — which is an ultrasound transducer that is small enough to be introduced to the blood vessel via a catheter. The drill can aim ultrasound directly ahead, which makes it extremely precise. It is also able to direct enough ultrasound energy to the targeted location to activate the nanodroplets, without causing damage to surrounding healthy tissue. The drill incorporates a tube that allows users to inject nanodroplets at the site of the clot.

During in vitro testing, the researchers compared various combinations of drug treatment, the use of microbubbles



and ultrasound to eliminate clots, and the new technique, using nanodroplets and ultrasound.

"We found that the use of nanodroplets, ultrasound and drug treatment was the most effective, decreasing the size of the clot by 40 percent, plus or minus 9 percent" says Xiaoning Jiang, Dean F. Duncan Distinguished Professor of Mechanical and Aerospace Engineering at NC State and corresponding author of the paper. "Using the nanodroplets and ultrasound alone reduced the mass by 30 percent, plus or minus 8 percent. The next best treatment involved drug treatment, microbubbles, and ultrasound — and that reduced clot mass by only 17 percent, plus or minus 9 percent. All these tests were conducted with the same 30-minute treatment period.

"These early test results are very promising."

"The use of ultrasound to disrupt blood clots has been studied for years, including several substantial studies in patients in Europe, with limited success," says co-author Paul Dayton, William R. Kenan Jr. Distinguished Professor and interim BME chair. "However, the addition of the low-boiling point nanodroplets, combined with the ultrasound drill has demonstrated a substantial advance in this technology."

"Next steps will involve pre-clinical testing in animal models that will help us assess how safe and effective this technique may be for treating deep vein thrombosis," says Zhen Xu, a professor of biomedical engineering at the University of Michigan and co-author of the paper.

The paper was co-authored by Huaiyu Wu and Bohua Zhang, who are Ph.D. students at NC State; and Jinwook Kim, a postdoctoral researcher in the Joint Department.

The work was done with support from the National Institutes of Health.

A startup called SonoVascular, Inc., which was co-founded by Jiang, has licensed the ultrasound "drill" technology from NC State. SonoVascular and NC State are hoping to work with industry partners to advance the technology. The low-boiling point nanodroplets, co-invented by Dayton, have also been issued a U.S. patent. That technology has been licensed by spinout company Triangle Biotechnology, Inc., which was co-founded by Dayton. Study co-authors Dayton, Kim, Xu and Jiang have also filed a patent application related to nanodroplet-mediated sonothrombolysis. •

FACULTY AND STAFF **NEWS**

Scott Magness

BME spin-out Altis Biosystems announces investment

Altis Biosystems, a company co-founded by BME associate professor Scott Magness and former chair Nancy Allbritton, recently announced completion of a $3.1 million seed investment led by VentureSouth. The company was founded to address the biopharmaceutical industry's intense need for more accurate drug screening methods using in vitro platforms, which can more closely replicate human biology. Altis has developed a stem cell technology called RepliGut, which produces a layer of human intestinal stem cells of either the small or large intestine to improve compound screening, disease modeling and microbiome research for pharmaceutical and biotechnology companies.

VentureSouth is one of the largest early-stage investment groups in the Southeast and invested more than $1 million as the first and largest investor in the fundraising. It was joined by local investors including RTP Capital and Hatteras Ventures, and other syndicate partners across the country including Atlanta Technology Angels and Central Texas Angel Network. With this seed series funding round, Altis will welcome new additions to its board of directors. These include Joe McMahon, former CEO of KBI Biopharma and k-Sep® Systems; Sue Mahony, former SVP and president of Lilly Oncology; and Sam Franklin, UNC graduate, nephrologist and member of VentureSouth.

Huang inducted into AIMBE College of Fellows

Helen Huang

The American Institute for Medical and Biological Engineering (AIMBE) has announced the induction of BME professor Helen (He) Huang to its College of Fellows — Class of 2021, for her outstanding contributions to rehabilitation engineering by developing breakthrough technology for assistive robotic prostheses and exoskeletons.

Huang was formally inducted along with 174 colleagues who make up the AIMBE Fellow Class of 2021 during the virtual AIMBE Annual Event on March 26. This year, AIMBE received a record number of nominations, so the selection process was more rigorous, which speaks to the remarkable accomplishments of Huang, Jackson Family Distinguished Professor and director of the Closed-Loop Engineering for Advanced Rehabilitation (CLEAR) in the Joint BME Department.

The College of Fellows is comprised of the top two percent of medical and biological engineers and membership honors a very select group of the most accomplished in the fields of medical and biological engineering, who are expected to contribute to AIMBE's critical mission of excellence and advocacy in biomedical engineering and medical innovation, enhancing and extending the lives of people all over the world. AIMBE Fellows have been awarded the Nobel Prize, the Presidential Medal of Science and the Presidential Medal of Technology and Innovation, and many are also members of the National Academy of Engineering, National Academy of Medicine and the National Academy of Sciences.

Dayton and Freytes named NAI senior members

BME Kenan Distinguished

Paul Dayton

Donald Freytes

professor and interim chair Paul Dayton and assistant professor Donald Freytes are among this year's 63 accomplished academic inventors named senior members of the National Academy of Inventors (NAI).

NAI senior members are active faculty members, scientists and administrators from NAI member institutions who have demonstrated remarkable innovation and produced technologies that have the potential for a significant impact on the welfare of society. NAI President Paul R. Sanberg said "NAI member institutions support some of the most elite innovators on the horizon. With the NAI senior member award distinction, we recognize and honor these innovators who are rising stars in their fields."

The 2021 class of NAI senior members represents 37 research universities, government and non-profit research institutes. They are named inventors on over 625 issued U.S. patents.

Department honors employees with Achievement Awards

BME Achievement Awards recognize the significant efforts made by faculty and staff members, post-docs and students in research, teaching and mentoring, as well as service to the department. In 2020, the selection was particularly difficult, given the number of outstanding nominees who have gone above and beyond their normal duties amid the pandemic.

The following awardees were selected from an impressive pool of nominees with support from the Department Awards Committee (Fran Ligler, Scott Magness, Roger Narayan, George Ligler and Naji Husseini) and help from members of the BME faculty, staff and trainees serving on review panels across UNC and NC State.

The 2020 BME Staff Service Award went to Lindsay Castret. The Teaching and Mentoring Award was given to Kennita Johnson. The BME Faculty Service Award went to Paul Dayton, BME interim chair. The Faculty Research Award was given to Devin Hubbard. The Postdoctoral Fellows Award for Outstanding Research Achievements was shared by Camilo Mora-Navarro (Freytes Lab) and Rebecca Krupenevich (Franz Lab). The awards for Ph.D. Student Achievement in Research went to Justin Huckaby (Lai Lab) and Emily Mihalko (Brown Lab).

Ke Cheng

Cheng receives Outstanding Research Award

Ke Cheng, a professor of regenerative medicine in NC State's College of Veterinary Medicine (CVM) and a professor in the Joint Department, is one of five NC State faculty members to receive a 2021 Outstanding Research Award, the university's top award for those who show excellence in their field and mentor their fellow research faculty members.

The award also includes induction into the Research Leadership Academy, a diverse team of accomplished faculty members dedicated to enhancing NC State's research culture.

CVM Dean Paul Lunn said Cheng has a "unique and exceptional vision for solving biomedical problems" and is "extremely unselfish" when mentoring junior scientists.

The Outstanding Research Award is given by the Office of Research and Innovation and the Alumni Association.

Cell Microsystems awarded two NIH grants totaling $2.1 million

Founded in 2010 by former BME chair Nancy Allbritton, Cell Microsystems recently received two National Institutes of Health Small Business Innovation Research (SBIR) awards: $318,000 for developing a novel hybridoma screening application and $1.8 million for establishing high-efficiency organoid workflows. Totaling $2.1 million, the two awards enable the company to be an integral part of advancing cancer and drug screening research forward.

BME associate professor Scott Magness and co-collaborator on the Organoid grant said, "We are so pleased that the NIH has recognized our continued research on organoid development, differentiation and characterization, which was made possible through a collaborative relationship with Cell Microsystems."

Cell Microsystems is an early growth stage company focused on developing, manufacturing and marketing innovative products for single cell biology research. The Company's lead products, the CellRaft® AIR™ System and CytoSort™ Arrays, enable complex workflows to be performed on a single consumable and uniquely suited to applications clonal propagation of single cells.

Jason Franz

Franz receives NIH grant to study falls in older adults

BME faculty member Jason Franz has been awarded a new Developmental Research Grant Award (R21) from the National Institutes of Health (NIH) for his proposal titled "The peripheral motor repertoire as a neuromuscular constraint on walking balance integrity in age-related falls risk." The project represents an exciting collaboration between researchers spanning biomedical engineering and physical therapy at UNC-Chapel Hill, chemical and biomedical engineering at West Virginia University and kinesiology and applied physiology at the University of Delaware.

Franz, the Applied Biomechanics Laboratory and their collaborators will test the overarching hypothesis that a reduction in the peripheral motor repertoire — a library of neuromuscular commands available across walking tasks during which falls could occur — represents a neuromuscular constraint on older adults' ability to successfully respond to balance perturbations and thereby prevent falls in the community.

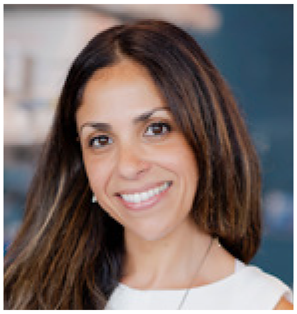
The work will be the first to combine state-of-the art electromyographic analyses; functional and neuropsychological measures of walking balance integrity, balance self-efficacy and fear of future falls; and a novel and diverse suite of sensory and mechanical balance perturbation paradigms applied during walking. Ultimately, the research aims to introduce a novel neuromuscular mechanism for age-associated balance impairment as a target for diagnostic testing and rehabilitation to prevent falls in older adults.

Velasco wins Faculty Dean's Performance Award

BME senior research technician Brian Velasco has won this year's Dean's Performance Award for his exceptional contributions in faculty support. Velasco exceeds expectations in all areas of the lab's administration. During COVID-19, he has been the only lab member to regularly be on site to maintain critical functions including cell lines, animal welfare checks, etc. In these challenging times, he has been entrusted to prepare key reagents for the lab and detailed quality control logs.

Brian Velasco

The Dean's Performance Awards honor UNC School of Medicine staff members whose exemplary work has contributed to UNC achieving its vision of becoming the nation's leading public school of medicine. The awardees are nominated by their peers and selected by the Administration Advisory Council in six different categories: diversity, community service, faculty, research, education and administration. Each winner receives $1,000 in acknowledgement of their extraordinary efforts.



Rahima Benhabbour

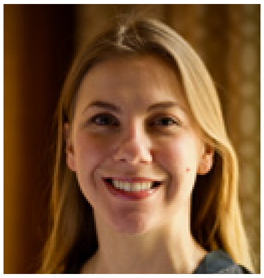
Benhabbour receives award to develop male contraceptive

Male Contraceptive Initiative (MCI), a private nonprofit foundation, announced a David Sokal Innovation Award grant to Rahima Benhabbour an assistant professor in BME and an adjunct professor at the UNC Eshelman School of Pharmacy, to support research and development of male contraceptive methods.

Benhabbour's award will aid her work toward developing long-acting delivery systems for male contraceptives. Specifically, the project focuses on using a novel long-acting implant that can be injected under the skin, forming a reversible implant that can deliver male contraceptives over a sustained period.

Benhabbour explained, "We are excited to develop an LA in-situ forming implant (ISFI)-based drug delivery system of non-hormonal male contraceptive(s) (NH-MC(s)) that can address the limitations of short-acting NH-MCs. The ISFIs will be injected subcutaneously to form a biodegradable drug / polymer implant and provide sustained and controlled delivery of a non-hormonal male contraceptive. These implants can be safely removed to terminate contraception or in the case of an undesired side effect or allergic response." •

STUDENT NEWS



Emily Ozpinar

Gabriela Torres

Ozpinar, Torres win Impact and Horizon awards

BME Ph.D. students Emily Ozpinar and Gabriela Torres have won the UNC Graduate School's 2021 Horizon and Impact Awards, respectively. A total of 16 UNC-Chapel Hill graduate students and alumni received the two awards for 2021.

Made possible through the Graduate Education Advancement Board, Impact Awards recognize discoveries of direct benefit to North Carolina. Horizon Awards recognize research likely to make a significant longer-term contribution to the state. Graduate students and recent graduate alumni apply for the annual awards and are nominated by their academic departments.

Students' presentation was runner-up at Ranger Regiment Symposium

BME undergraduate students William Arana, Macy Farrar and Joseph Fisher participated at the 75th Ranger Regiment inaugural Academic Research Symposium, hosted virtually through Zoom on Sept. 30, 2020.

Their presentation, "Longevity of blood: Researching the ability to increase whole blood shelf-life in combat zones and the possibility of developing a way for all blood types for universal donation" won second place among 12 capstone projects, with 13 universities represented.

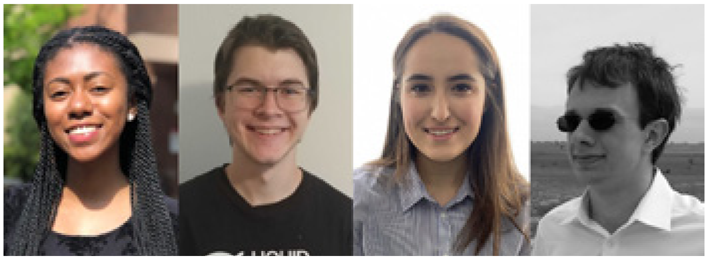
The symposium highlighted the breadth of projects and partnerships between the regiment and universities across the United States, served as formal introduction between capstone project leaders and regimental leaders, and cast the foundation for a sustained partnership to employ academia to solve Department of Defense problems.

BME students help NC State take home ACC InVenture Prize

NC State's team, which included two BME undergraduate students, was selected as the first-place winner for the 2021 Atlantic Coast Conference (ACC) InVenture Prize competition.

Biomedical engineering students Monique Reid and Chloe Sanchez-Prado teamed with electrical and computer engineering students Alexander Allen and Keith Mellendorf. The team is developing UV Scope, a handheld UV spectrometer that will enable food processing and medical professionals to measure the bacterial concentration of a surface in real-time.

The team aims to take technology that currently only exists in a research lab environment using extremely expensive equipment. They are building a compact device that leverages recent advancements in sensors and electronics to change the way sanitation is measured and validated everywhere.



From left, Monique Reid, Keith Mellendorf, Chloe Sanchez-Prado and Alexander Allen.

A *Shark Tank*-style competition where the best ACC university student entrepreneurs pitch before a live audience and panel of judges for cash prizes, the InVenture Prize competition was established in 2016 and is the nation's largest undergraduate student innovation competition.

BME seniors selected to join the Clinton Global Initiative

MUSE Biomedical, a team of BME seniors who are developing medical devices focused on preventing opioid addictions, has been recognized by the Clinton Foundation and has been selected to join the 2021 Clinton Global Initiative. The program will provide the MUSE team with connections / further mentorship, Clinton Foundation topic experts and access to new funding streams.

MUSE team members, BME students Tasneem Omar Essader, Goutam Kumar Gadiraju, Jennifer Jacober, Pradham Venkata Tanikella and Karthik Kaundinya, are also invited to participate at the virtual meeting hosted by Bill and Chelsea Clinton this year.

Jordan Baer Joiner

Joiner wins second place at the 2020 PharmAlliance Symposium

UNC pharmacoengineering Ph.D. student Jordan Baer Joiner won second place at the 2020 PharmAlliance Symposium for her talk "Low-intensity focused ultrasound produces immune response in pancreatic tumors," which stems from her research in BME's Dayton Lab.

In January 2019, Joiner joined the Dayton Lab, where she is advised by BME interim chair and professor Paul Dayton, to combine therapeutic ultrasound with immunotherapy to treat pancreatic cancer. She also works in the lab of BME assistant professor Rahima Benhabbour to formulate injectable in-situ forming implants that sustain drug release and can be non-invasively imaged with ultrasound.

MacKinnon wins the Bruker MRI Award

BME Ph.D. student Martin MacKinnon was the first-place winner of the Bruker MRI Award for his entry iZTE-fMRI at the 2020 virtual meeting of the International Society for Magnetic Resonance in Medicine (ISMRM).

MacKinnon demonstrated how a zero-echo-time (ZTE) technique can overcome several limitations of traditional fMRI experiments. Also, he showed that iZTE fMRI experiments can produce functional images with markedly less susceptibility artifacts and acoustic noise than standard GRE techniques. MacKinnon said, "It was a great experience to win the Bruker MRI award and be able to speak to the preclinical imaging community alongside leaders in the field."

2020-21 ABRAMS SCHOLARS NAMED

The BME Department is pleased to announce the 2020-21 cohort of Abrams Scholars. This year, 38 excellent BME undergraduates were selected from a very strong applicant pool to receive a mentored research fellowship funded by the NC State College of Engineering Research Experience for Undergraduates program.

The BME Abrams Scholars Program provides outstanding BME undergraduate students at both UNC and NC State with the opportunity to conduct hands-on, mentored research projects throughout the academic year (September through April). The scholars are highly motivated students who are generally very productive in the lab, often presenting their work at local, regional and even national conferences (such as BMES and IEEE meetings) and co-authoring journal articles.

NC State recipients are: Kathryn Benedict, April Brown, Caroline Dau, Mary Erb, Noor Hakam, Aasim Hussain, Carina Iboaya, Manasi Krishnakumar, Tahia Monjuli, Bevin Neill, Ana Laura Pantaleão dos Santos, Emily Pierce, Jennifer Potts, Bhairavy Puviindran, Vincent Roche, Jake Schulman, Dylan Silkstone, Matias Tenorio, Matthew Traenkle, Christopher Vogel and Annie Kate Watson.

UNC recipients are: Allison Boyer, Anne Hope Cooper, Noah Dover, Jordan Feldman, Callum Funk, Luciana Herrero, Kamellia Karimpour, Maddison Khire, Jeehyun Kim, Rohan Krishnan, Napoleon Nguyen, Nita Prabhu, Mohini Sauhta, Sahil Sethi, Elizabeth Stanley, Emily Warren and Jason Xie. •

ALUMNI AND INDUSTRY **NEWS**

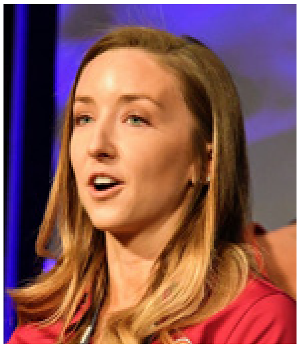
Stephanie Cone

Recent BME graduate **STEPHANIE CONE** was one of 20 Rising Stars selected from a pool of more than 160 global applicants to present at the inaugural Engineering in Health virtual workshop hosted by Columbia University on Dec. 18, 2020.

Cone is currently a postdoctoral fellow in the University of Wisconsin Neuromuscular Biomechanics Lab researching non-invasive techniques for characterizing tendon function during dynamic tasks. She completed her Ph.D. in 2019 with associate professor Matthew Fisher in the Translational Orthopaedics Research Lab, where she studied structural and functional changes in the knee during growth.

At Columbia University, the Fu Foundation School of Engineering and Applied Science and the Vagelos College of Physicians and Surgeons (were pleased to present this inaugural Rising Stars Workshop at the intersection of engineering and health science, with the aim of educating the next generation of scientists. To read more about the event, visit **bit.ly/3fU4UNP**.

BME alumna **JAMIE CONE**, who graduated from NC State with a concentration in biomaterials, is currently an engineer II at BD Technologies & Innovation in North Carolina's Research Triangle Park. One of her main responsibilities involves using additive manufacturing (AM) equipment in the development of medical components.



Jamie Cone

"Because I work for a huge medical injection molding company that molds billions of parts per year, 3D printing introduces a whole new way of thinking and designing for medical components. I have been part of the most recent efforts to try and educate and persuade other engineers within our company to think differently and to trust that AM can be an alternative method to traditional manufacturing, and one that can significantly save time and money," she said.

During the pandemic, BD Technologies & Innovation focused its resources on equipping healthcare partners with a comprehensive suite of technologies and solutions to discover more about COVID-19, diagnose patients at scale and support patient care. BD experienced unprecedented demand for certain equipment, and their "manufacturing facilities had to massively increase production," said Cone. "In some cases producing more in one week than in the whole of the previous year."

The feature further quotes Cone's experiences as a woman engineer, the importance of exposing young girls to engineering and science activities early, and motivation for pursuing a career in engineering. To read the full article, visit **bit.ly/39RvpPQ**.

BME alumnus **CONRAD DEAR**, a second-year medical student at the Uniformed Services University of the Health Sciences (USU), has developed a unique monitoring device

Conrad Dear

for neonatal tracheostomy patients, the TrachTracker.

This device stemmed from his senior design project as a BME major at NC State, where he investigated and prototyped the TrachTracker with four other engineering students. They met with doctors and nurses from the NC Children's Airway Center and the team won the i4 Competition sponsored by the Joint BME Department.

"Our university really believed in us," said Dear. The team decided to use the prize money to pay patent lawyer fees and continue prototyping.

The TrachTracker is currently undergoing utility patent approval. The device reads muscle activity off the neck, as well as heart rate. When the electrical readings from these two signals form the right combination, a computer algorithm recognizes it and produces an alert. The computer will output a message to the parents to let them know that their child is in a state of distress and needs some attention or comfort.

Recent joint BME graduates **podcast for job-and-internship-seeking** BME juniors and seniors

Two 2019 UNC / NC State BME graduates, **ALLIE MITZAK** and **GRACE CRONIN**, are hosting The BME Grad Podcast to help job-seeking BME students understand industry job roles. They also provide BME-focused advice on topics such as networking, the job search process, interviews, job applications and resumes.

The podcast evolved out of weekly *Zoom* calls Mitzak and Cronin were hosting in December 2020 for job- and internship-seeking BME juniors and seniors. "We set up these calls because we had the privilege of being able to experience internships and networking events in person when we were in college. We got to meet and work with people in different job roles. We were able to see the different responsibilities of departments in companies and how they interact with each other. With everything

Allie Mitzak, left, and Grace Cronin.

being remote now due to the COVID-19 pandemic, we thought it might be useful to provide these insights to students that didn't have the chance to see them up close before beginning the job search," said Cronin.

After several successful sessions with groups of BME students, they began recording. "In addition to providing advice on interviews, networking and job searching, we started bringing on guests. We'd ask recent BME grads from the program or working in RTP to come on the show and interview. We wanted to provide an in-depth picture of what their job title meant, what they did every day and their company type and dynamics. We thought it might be helpful for the audience to hear this from BMEs close in age to them, that can bridge the gap between what they knew in college and what they know now," said Mitzak. From just 10 episodes, the two have connected with more than 30 students in the Joint Department, and more BMEs from all around the world through sharing their podcast on *LinkedIn* and *Facebook*.

Since the start of the podcast in January 2021, Mitzak and Cronin have hosted guests working in product engineering, manufacturing, project management, marketing, clinical, regulatory and entrepreneurship roles. They have also featured subject matter experts in interviewing and resume writing.

"We hope to keep up the same interview-style episodes with recent grads, but increase our mix by hosting more subject matter experts and also recording some 'grass-roots advice' episodes. We want to expose the mistakes and learnings ourselves, recent grads and soon-to-be grads have experienced in the job search process, so each class of BMEs gets sharper," said Mitzak.

"We are so grateful for the wide support of the students and guests that have shaped what the podcast has become, and we hope to keep the momentum going this spring and summer," said Cronin.

The **BME Grad Podcast** can be found on *Anchor, Spotify, Apple Podcasts, Google Podcasts, Breaker, Pocket Casts* and *RadioPublic.* •

ZOOMING IN ON **CAREER OPPORTUNITIES**

Job hunting in a virtual environment is a challenge. BME students met this challenge straight on every Wednesday night during February Industry Networking Nights via *Zoom*.

The first Industry Networking Night in 2019 was successful. As one student described the event last year, "The BME Industry Networking Night was a great event that allowed students to learn about different companies and roles specifically suited for BME and to meet with engineers, scientists and other professionals in the field. I had the opportunity to learn more about various career options and landed an internship with one of the companies present — even during the pandemic."

Employers were equally positive and returned this year to participate. Heidi Kay of Jericho Sciences said of last year's event, "Students attending the Industry Networking Event were fully prepared and professional, with many excellent, enthusiastic candidates. Jericho has worked with students in this program to develop programming code, analyze data, perform laboratory assays, troubleshoot instruments and more. The eight-week summer internship is a win-win experience, and an opportunity to leverage unique resources of the RTP academic and business community."

Thanks to our industry participants this year, including Advanced Animal Diagnostics; BioMerieux, Inc., represented by BME alumnus Alexander Earle; Humacyte, Inc.; Merck, represented by BME alumnus Matt Lamore; MethodSense; Pfizer Rocky Mount site, represented by BME alumnus Alex Brown, and Pfizer, Sanford site, represented by BME alumnus Jordan Hjelmquist; SunTech Medical; and Yukon Medical, LLC. BME juniors and seniors were able to attend these virtual networking nights to hear of specific opportunities available as well as general career development tips. Thank you again to all who participated.

A strong alumni network will help BME students and graduates secure interesting, challenging and meaningful work as interns and new employees. If you and your company would like to be participate in future career education and recruiting events, please reach out to **Laura Schranz**, **lschranz@unc.edu** or **lschran@ncsu.edu**.

Joint Department of
BIOMEDICAL ENGINEERING

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SAVE THE DATE

CONVERSATION AND UPDATE WITH PAUL DAYTON

PAUL DAYTON

William R. Kenan Jr. Distinguished Professor and Interim Department Chair

Aug. 11, 2021 ▪ 4 - 5 p.m. EST

Paul Dayton will be hosting an information session in August to provide updates regarding the growth of the UNC / NC State Joint Department of Biomedical Engineering. This can be an opportunity to learn more about research that faculty members and students are engaged in, ask questions about the department and explore how you and your company might be involved with BME. It is also a great way for those of us in the BME department to learn about you, our alumni.

We look forward to seeing you there.

*Join via Zoom Meeting: **bit.ly/3dl6mBr**.*