

BreakThroughs

WINTER 2021



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Setting Sights on a Cure

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Finding the Answers, Together



MICHAEL B. KASTAN

ON THE COVER:

Setting Sights on a Cure. Breast cancer patients have more treatment options than ever before, including a new one developed at Duke that is in clinical trials for advanced cancer (see page 13). One Duke researcher who helped lead the development of that drug thinks he can make even more progress by shifting gears to focus on enhancing the body's own immune system (see page 8).

IT TAKES ALL OF US—scientists, physicians, nurses, donors, volunteers, patients, and families, to defeat an enemy as formidable as cancer.

Heather Paradis fits into many of those categories—nurse practitioner, donor, volunteer, and caregiver of a family member. I know you will be inspired by the story of how she is using all of her experiences to help others.

In this issue of *Breakthroughs*, you will also learn about a \$3.5 million grant that Duke Cancer Institute (DCI) has received from the National Cancer Institute to develop new ways to understand why certain cancers are more common and more aggressive among some populations. This grant builds on DCI's long-standing efforts in health disparities, some of which was previously funded by a DCI Pilot Grant and grants from the V Foundation for Cancer Research and the Lung Cancer Initiative of North Carolina. When you hear good news about large federal grant awards, what often isn't mentioned is the years of work the researchers devoted to gathering

PROGRESS LIKE THIS WOULDN'T BE POSSIBLE WITHOUT ALL OF US DOING OUR PART.

enough data to win them. That early work is where philanthropy often plays a key role.

You'll also read here about the latest in new treatments for breast cancer, even for advanced disease. One such new treatment now in clinical trials, lasofoxifene, had made it to the clinic only because of the inspiration and work of several dedicated Duke trainees and scientists.

Progress like this wouldn't be possible without all of us doing our part. Will you please join us?

A handwritten signature in blue ink that reads "Michael B. Kastan".

Michael B. Kastan, MD, PhD
Executive Director, Duke Cancer Institute
William and Jane Shingleton Professor,
Pharmacology and Cancer Biology
Professor of Pediatrics

Breakthroughs is produced two times a year by Duke Cancer Institute Office of Development
300 West Morgan Street, Suite 1200
Durham NC, 27701 • Phone: 919-385-3120

Advisory Committee: Rachel Greenup, MD;
Donald McDonnell, PhD; Steven Patierno, PhD;
Hope Uronis, MD

Assistant Vice President, Development,
Duke Cancer Institute
Amy Deshler

Publisher Amy Deshler
Editor Angela Spivey

Writers Julie Poucher Harbin, Aliza Inbari,
Mary-Russell Roberson

Art Director/ Design David Pickel

Photography Alex Boerner, Ken Huth,
David Pickel, Shawn Rocco, Jim Rogalski

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A Call to Respond to COVID-19

Gut bacteria help regulate your immune system. Can priming them with a probiotic protect against COVID-19?

A Duke Cancer Institute physician-scientist and a critical care specialist are exploring that question in a clinical study being conducted remotely and made possible by philanthropy.

Anthony “Tony” D. Sung, MD, a stem cell transplant physician and associate director of the Duke Microbiome Center, and Paul Wischmeyer, MD, professor of anesthesiology and surgery, were both familiar with studies showing that taking a probiotic can reduce the risk of respiratory infections and even more severe infections such as sepsis.

Wischmeyer himself had conducted research showing that, in a mouse model of pneumonia, giving the mouse a probiotic (*Lactobacillus rhamnosus GG*) protected against infection and improved survival.

Then the pandemic cemented a partnership. “In the setting of COVID-19, we have a call to respond,” Sung says.

They launched a trial that tests whether taking a common, over-the-counter probiotic (the same one that Wischmeyer used in his study

with mice) can help prevent symptoms or reduce their severity in people who live with someone who has tested positive for COVID-19. Participants receive the probiotics and submit nasal swabs and fecal samples by mail.

“There are lots of data supporting



this as a viable hypothesis, but it’s a hypothesis that needs to be tested,” Sung says. While he can’t make recommendations about taking probiotics until the trial is complete, he acknowledges that since the pandemic began, he has been taking one himself, as does his two-year-old daughter, who spent time in the ICU with a common cold as a baby.

An established investigator funded by the National Institutes of Health (NIH), Sung hadn’t funded his research with philanthropy before.

But the pandemic prompted him to contact his former classmate from Stanford University, Joe Lonsdale, who made a \$40,000 gift through his company, Lonsdale Enterprises.

“Tony embodies a lot of great traits, including brilliance, integrity, and hard work,” Lonsdale says. “It’s an honor to be able to support a researcher like Tony with resources to work on ways to ameliorate the terrible impact of COVID-19.” The Duke Microbiome Center and several other individuals also funded the study.

The trial is open now and would not be possible without donor support.

“There was a grant application we sent to the NIH around the same time that we started this study. We still have yet to hear back whether that is funded,” Sung says. “Philanthropy allows us to move much more quickly and react to emergencies like COVID-19.”

HOW YOU CAN HELP

To make a gift to support the study, visit bit.ly/protectehc.

Colorectal Cancer Conversations Win Award

The Durham County Colorectal Cancer Screening Workgroup, Duke Division of Gastroenterology, and Duke Cancer Institute received an award for “Best Culturally Inclusive Social Media Event” from the American College of Gastroenterology.

The group received a 2020 SCOPY (Service Award for Colorectal Cancer Outreach, Prevention, and Year-Round Excellence) for their entry “Duke Cancer Institute Facebook Live Event for Colorectal Cancer Awareness Month.”

The afternoon of three different public conversations with providers and cancer survivor Tristan Evans about colorectal cancer screening was live-streamed on March 2, 2020: one in English, one in Spanish, and one in Chinese. The conversations were simulcast on the Facebook pages of the Durham County Department of Public Health and the Duke Cancer Institute.

The Durham County Colorectal Cancer Screening Workgroup includes Angelo Moore, PhD, RN (Program Manager, Duke Cancer Institute Office

of Health Equity); Chelsea Hawkins, MPH, MCHES (then Public Health Education Specialist, Durham County Department of Public Health); Willa Robinson Allen, MPH, MHED, MCHES (Program Manager, Durham County Department of Public Health); and Elaine Hart-Brothers, MD, MPH, FACP (Founding Director, Community Health Coalition, Inc.).

Other Duke providers and staff who played a part in the event: Jessica Hyland, Tzu-Hao Lee, MD; Andrew Muir, MD; Aleecia Smith, PhD; Julius Wilder, MD; and Ping Zhang.



ABOUT TIME

As the COVID-19 pandemic shines a light on health disparities, efforts to find new ways to reduce them get a boost.

Lung cancer is responsible for the greatest number of cancer deaths each year in the United States and in North Carolina, and African Americans carry a disproportionate share of this burden. African Americans are more likely to be diagnosed with lung cancer and more likely to die from it, compared to White people.

Stomach cancer is not as common, but the disparities are worse. Nationwide, people of color are twice as likely to develop stomach cancer. In seven counties served by the Duke Cancer Institute (DCI), the incidence of stomach cancer among African Americans is three to four times that of Whites. Black people are also 2 1/2 times as likely to die of stomach cancer than Whites, which is the biggest mortality disparity of any cancer in the United States.

A group of researchers at the Duke Cancer Institute (DCI) is working to change those statistics, and a new federal grant is giving them a big boost.

“This effort is part of the overall global initiative across Duke to address health disparities and across DCI to address cancer health disparities,” says Steven Patierno, PhD, professor of medicine and deputy director of the Duke Cancer Institute.

Patierno is principal investigator of the grant, which supports two projects—one relating to lung cancer, and the other to

stomach cancer. “Both projects will produce information that can influence and change clinical paradigms,” Patierno says.

The grant, an Exploratory Grant (P20) from the National Cancer Institute to develop a Specialized Program of Research Excellence (SPORE) (*see SPORE box, page 6*), is intended to help establish the necessary foundation to grow a program capable of winning a larger Specialized Center (P50) SPORE grant. At that point, the program would be expanded to address disparities in other types of cancers.

MULTIPLE FACTORS

Health disparities related to cancer are caused by a multitude of factors that create worse outcomes for people of color, including limited access to health care and screening, environmental and lifestyle factors, institutional racism, implicit bias, fear and mistrust, language barriers, lack of transportation, and more.

One of the many factors influencing cancer disparities is biology. “At the biological level, it can go in either direction,” Patierno says. For example, White people are more likely than African Americans to be diagnosed with bladder cancer, while the reverse is true for kidney cancer.

“If we can identify risk factors that might be associated with where and in which direction a particular patient’s ancestors left Africa—and we’re all out of Africa—that ancestral lineage might help us identify people who may

be at higher risk for specific cancers, aid in prevention and early detection efforts, and help us identify novel targets for drugs,” Patierno says.

RNA SPLICING IN LUNG CANCER

Jennifer Freedman, PhD, and Jeffrey Clarke, MD, both assistant professors of medicine (medical oncology) are coleading the lung



Jennifer Freedman (center front), Steve Patierno (far right) and other researchers previously found RNA splicing differences in prostate cancer between African American men and White men. Now Freedman studies RNA splicing differences in lung cancer.

BY MARY-RUSSELL ROBERSON

cancer project. In a previous project, they identified biological differences among lung cancer tumors from White and African American patients. This work, which was funded by the V Foundation for Cancer Research, the Lung Cancer Initiative of North Carolina, and a Duke Cancer Institute Pilot Research Award, set the stage for the P20 SPORE funding.

The differences they found are related to how genes express themselves through RNA splicing, which is the process that allows a limited number of genes to create an enormous number of proteins.

Freedman explains, “If RNA splicing breaks down or is dysregulated, it can cause cells to make proteins they don’t normally make, and that can lead to many different diseases, including cancer.”

Freedman and Clarke compared RNA splicing in tumors from 14 patients of West African ancestry and 11 patients of European ancestry. “We found differences in RNA splicing by ancestry which had never been seen before,” she says. “So we identified a new biological characteristic that was different in lung cancer in patients of African ancestry.”

They also found that some of those splicing differences are associated with shorter survival rates.

The new federal funding will allow the researchers to take the next steps. “Moving forward,” Clarke says, “the goal is to confirm this finding in a larger number of lung cancer samples and ultimately understand the biology so that we can develop new treatments and help

mitigate disparities in lung cancer.”

Freedman and Clarke will manipulate cells in the lab so they express either the RNA splicing variants seen in people of West African ancestry or the variants seen in those of European ancestry. “Then we’ll see how these cancer cells differ,” Freedman says. “Does one grow faster than the other? Does one spread faster than the other?”

Once the researchers understand the mechanisms of the splicing variants, they’ll be able to identify targets for drugs that could keep the harmful splicing events from happening.

Patierno says RNA splicing differences offer a potentially rich opportunity for reducing disparities not only in lung cancer, but in many other cancers as well. He and Freedman previously discovered RNA splicing differences in prostate cancer between African American men and White men. In fact, Patierno says, there are ancestry-related RNA splicing alterations in at least 18 genes whose function is implicated in five different kinds of cancer—prostate, breast, colon, and two kinds of lung cancer. Seven of those genes are also involved in four other types of cancer—cervical, liver, pancreatic, and uterine cancer.

STOMACH CANCER: A BACTERIUM IS ONLY PART OF THE STORY

The vast majority of cases of stomach cancer in the United States are caused by infection with *Helicobacter pylori*. In some people, the bacterium causes no

symptoms, but in other people it causes ulcers, inflammation, and other kinds of damage that can eventually lead to cancer. About 3 percent of people with *H. pylori* will develop stomach cancer; clearing up the infection with antibiotics cuts that risk in half.

The incidence of ulcers and stomach cancer has declined over the past century as improved hygiene and the use of antibiotics have cut down on the prevalence of *H. pylori*. But neither *H. pylori* nor stomach cancer have been eliminated, and both the bug and the disease are more common among African Americans than Whites.

That really bothers Meira Epplein, PhD, an associate professor in population health sciences and medicine (medical oncology) whom Patierno describes as “one of the leading experts on *H. pylori* in the world.” She calls stomach cancer “highly preventable.”

However, *H. pylori* is only part of the story, because African Americans with the infection are more likely to develop stomach cancer than Whites with the infection. Other risk factors for stomach cancer include smoking, a high-salt diet, and family history. Researchers suspect that the biology plays a role as well: It may be that certain strains of *H. pylori* are more carcinogenic than others or that certain aspects of a person’s immune response create conditions that encourage cancer.

“We’re trying to figure out the biology behind what’s happening,” says Epplein,

Specialized Program of Research Excellence (SPORE) Grant to Investigate Cancer Health Disparities

PURPOSE: To continue building a multi disciplinary program of translational research in cancer disparities.

FUNDER: National Cancer Institute of the National Institutes of Health

LENGTH: 2020-2023

SIZE OF GRANT: An Exploratory (P20) SPORE grant in the amount of \$3.5 million was awarded to support two research projects and provide a foundation for future growth.

PRINCIPAL INVESTIGATOR: Steven Patierno, PhD, deputy director of the Duke Cancer Institute

PROJECTS SUPPORTED BY THE P20 SPORE:

- Lung cancer disparities, led by Jennifer Freedman, PhD, and Jeffrey Clarke, MD
- Stomach cancer disparities, led by Meira Epplein, PhD, and Katherine Garman, MD



Meira Epplein

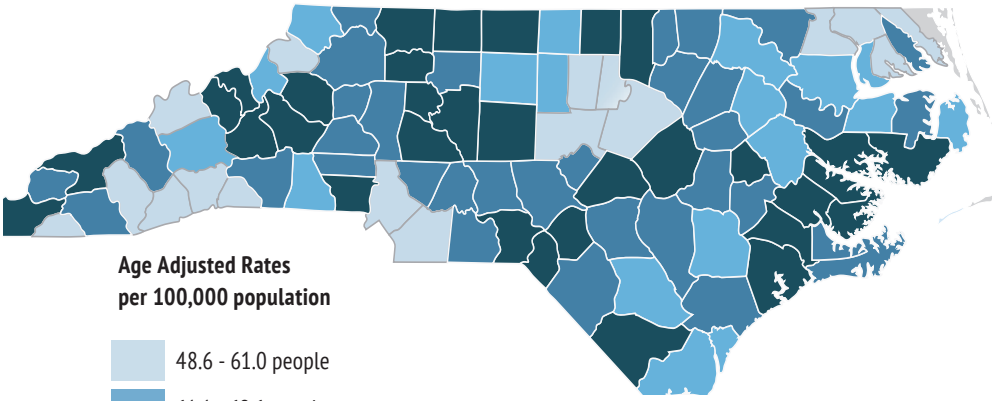


Katherine Garman

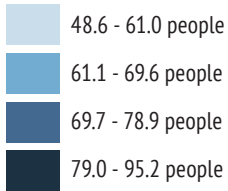


Jeffrey Clarke

NORTH CAROLINA LUNG CANCER INCIDENCE RATES 2010-2014



Age Adjusted Rates per 100,000 population



SOURCE: N.C. State Center for Health Statistics

who is co-leading the stomach cancer project with Katherine Garman, MD, associate professor of medicine (gastroenterology).

The researchers will analyze a large number of previously banked tissue specimens from people who had *H. pylori* along with information about their disease and lifestyle factors such as smoking. They will also invite patients who are scheduled for upper endoscopies (in which a physician examines the lining of a patient's esophagus and stomach with a flexible tube and camera) to fill out a detailed questionnaire, donate tiny tissue samples, and agree to let the researchers keep track of the progression of their disease.

In both of these studies, researchers will look for clues in the strain of bacteria, the patient's immune response, and lifestyle factors to see if they can find patterns that help account for the worse outcomes for African Americans. If certain strains or immune responses are more likely to lead to stomach cancer, that information could be used to identify patients who need *H. pylori* screening and treatment.

STOMACH CANCER

Incidence of Stomach Cancer by Race in the United States



Black men are **1.8** times more likely to have stomach cancer than White men



KEN HUTH

"WE'RE RIGHT AT THE APEX OF CHANGING THE WORLD RIGHT NOW, MITIGATING CANCER DISPARITIES WITH THE GOAL OF ACHIEVING HEALTH EQUITY."

– Steve Patierno

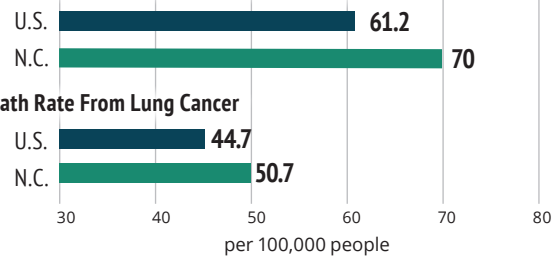
"For a rare cancer like stomach cancer, it's better to identify which patients are at highest risk and then focus our preventive efforts on those patients," Garman says. "It doesn't make sense to apply screening to a large population for a cancer that's rare."

As a clinician, Garman is also excited to generate data that will inform guidelines to help her and her colleagues manage patients who have certain types of tissue damage that sometimes, but not always, lead to stomach cancer. Right now, there's no way to know which of these people need more aggressive treatment and which simply need to be monitored.

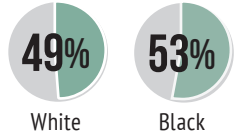
Patierno, who has worked in cancer disparities for decades, says that the COVID-19 pandemic is shining a spotlight on health disparities in a way that adds new urgency to all of this work. "We're right at the apex of changing the world right now," he says, "mitigating cancer disparities with the goal of achieving health equity."

LUNG CANCER

Incidence of Lung Cancer per 100,000 people



North Carolina: At Diagnosis Lung Cancer Had Spread to Other Parts of the Body



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THE DRUG GUY CHANGES COURSE

AFTER A SCIENTIFIC MEETING IN NEW HAMPSHIRE IN 2017, breast cancer researcher Donald McDonnell, PhD, met his wife, Mary, in Maine for a week of vacation. Sitting at a secluded inn on Anne's Point, McDonnell, coleader of the Women's Cancer Research Program at the Duke Cancer Institute, couldn't stop thinking about what he had heard at the meeting.

He couldn't shake the thought that he and everyone else had been taking the same general approach to treating estrogen-receptor-positive breast cancer for more than 30 years.

What many breast cancer drugs have in common is that they stop production of the hormone estrogen or block its effects. Over the years, researchers have gotten better and better at developing anti-estrogen drugs, which interfere with the estrogen receptor in

the cancer cell. Some bind to the estrogen receptor in place of the hormone, while others bind and "twist the receptor into an unnatural shape," McDonnell says. "The cell thinks it's a broken protein, then eats it."

McDonnell's own lab has had a role in the development of the majority of these drugs (*see "A Bench to Bedside Story," page 13*). That is no small feat: for many patients, the treatments hold the cancer at bay. In fact, in 2020, McDonnell was recognized with the Susan G. Komen Brinker Award for Scientific Distinction in Basic Science, the organization's highest scientific honor, for his contributions to improving understanding of estrogen receptor signaling, leading to development of novel endocrine therapies for breast cancer that is positive for the estrogen receptor.

But sitting there in Maine in 2017, looking at the calm water, McDonnell decided that he could do better.

"I decided that I had to get off the path I was on," McDonnell says. "My group has done as good a job

BY ANGELA SPIVEY



as we could possibly do developing drugs to stop the growth of breast tumors. What I want to do now is eradicate them.”

That decision has led McDonnell, the Glaxo-Wellcome Professor of Molecular Cancer Biology, to shift from “studying the breast cancer cell in a vacuum” to looking at therapies in the context of the immune system. Early findings from his team of collaborators show promise for finding treatments that are more targeted and effective than ever before.

IS THIS A STUPID IDEA?

In 2017, when McDonnell got back from Maine, he started thinking about estrogen’s effect on the eight or

nine different immune system cells that live outside the cancer cell. “Most of them also express the estrogen receptor,” he says. So when a woman takes an anti-estrogen pill, it’s not only inhibiting the action of the hormone in the cancer cell, but in all of those immune cells. “We know that beating the hell out of the estrogen receptor in the cancer cell is a good thing, but is it a good thing in the other cells?” McDonnell says. “And the answer is, I don’t think so.”

As these ideas emerged, McDonnell had doubts. He didn’t know much about immunology. Plus, by changing course, it would be like saying he had been doing things wrong all this time. But he has never been one to keep to the status quo. As a college student at the National University of Ireland, Galway, with a scholarship to study marine biology, he switched his plans after meeting his future wife and getting to know her mother, who was battling breast cancer.

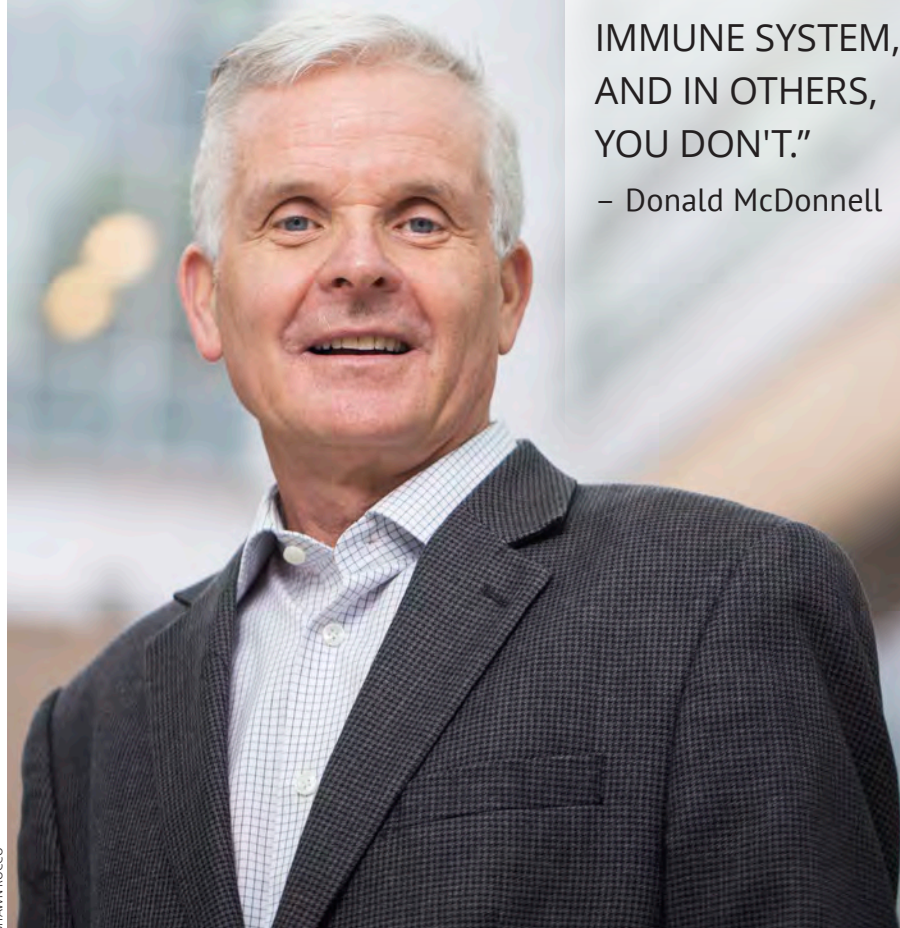
Decades later, thinking about changing paths again, he called his colleague, Nelson Chao, MD, for advice.



TIME TO REFLECT: During a vacation with his wife, Mary, in a secluded spot in Maine, Donald McDonnell decided to change his focus to study breast cancer and the immune system.

“WE’VE BEEN ABLE TO SHOW THAT IN SOME BREAST CANCERS, YOU WANT TO INHIBIT ESTROGEN RECEPTORS IN THE IMMUNE SYSTEM, AND IN OTHERS, YOU DON’T.”

– Donald McDonnell



SHAWN ROCCO

Chao, the Donald D. and Elizabeth G. Cooke Cancer Distinguished Research Professor at Duke, has extensive expertise in stem-cell transplant and in immunology.

“I said, ‘Listen Nelson, is this a stupid idea?’ And he said ‘No, I think it’s worth looking at.’”

So McDonnell consulted his lab group, got their ideas, and wrote a grant application to the Department of Defense (DOD). Funded in 2018 with \$7.3 million, the project involves McDonnell, his research team, and more than a dozen physicians, scientists, and staff from different departments at Duke, as well as researchers in genomics and drug discovery at UNC-Chapel Hill.

The work includes a clinical study led by Sarah Sammons, MD, assistant professor of medicine (medical oncology). The study has followed, for two years, 200 women with estrogen-receptor-positive breast cancer, beginning when they started endocrine therapy (following surgery, radiation, and chemotherapy). The researchers assessed in the lab whether the anti-estrogen drugs had a positive, negative, or neutral effect on the patients’ immune systems.

The answer, which isn’t published in the scientific literature yet, is that it depends on the type of breast cancer and its immune profile. “We have defined about three different facets of immune biology that we believe

the estrogen receptor regulates in an important manner in breast cancer,” McDonnell says.

“We’ve been able to show that in some breast cancers, you want to inhibit estrogen receptors in the immune system, and in others, you don’t.”

Breast cancer types vary so much that it could be considered several different diseases, McDonnell says. So figuring out how to use this information will require more work, though other findings from his lab about estrogen and the immune system are leading to a more immediate payoff for other cancers (see “A Detour into Melanoma,” page 11).

DESIGNING THE PERFECT COMPOUND

In the third year of the four-year DOD grant, the team is moving to what McDonnell considers the main event: developing breast cancer drugs that keep their ability to stop growth of the cancer cell, but that don’t have bad effects on the immune system.

Step one: screen current estrogen-inhibiting therapies to find out which ones have the most favorable effects on immune cells. “There’s no way to change standard of care tomorrow. It will be a gradual approach,” McDonnell says. Step two: collaborate with Tim Willson, PhD, a research professor in the Eshelman School of Pharmacy at UNC-Chapel Hill, to create new drugs. “We now know the characteristics of the perfect compound. Now we just have to design it,” McDonnell says.

Whether it’s McDonnell’s team that creates the perfect therapy, or someone else, he believes that by collaborating across disciplines and focusing on enhancing the body’s own defenses, researchers are on the cusp of being able to cure breast cancer. “With immunotherapy, we have durable clinical responses in melanoma and lung cancer,” he says. “Although it is a more daunting task, there’s no reason to my mind that we can’t hijack the immune system to do the same thing in breast.”

A DETOUR INTO MELANOMA



JIM ROGALSKI

A BREAST CANCER RESEARCHER'S STUDY OF ESTROGEN ACTION MAY LEAD TO BETTER TREATMENTS FOR OTHER CANCERS

POSTDOCTORAL FELLOW BINITA CHAKRABORTY, PHD, was intrigued: in published analyses of large numbers of patients with melanoma (skin cancer) treated with an immunotherapy that is becoming standard of care, the treatment worked better in men than in women. “There may be multiple reasons why the response may be different between males and females,” she says. “But one of

the biggest differences that stands out was circulating estrogen levels. Estrogen levels are much higher in females than males.”

As a breast cancer researcher, Chakraborty knows a bit about estrogen. When she told her mentor, Donald McDonnell, PhD, that she wanted to explore what was really behind this connection, he told her to run with it.

Her findings are leading to a Duke clinical trial in the works that may make immunotherapy work better for people with melanoma, as well as other cancers.

New to studying skin cancer, Chakraborty knew just who to call—Duke physician-scientist Brent Hanks, MD, PhD, who treats patients with melanoma and studies the disease. Hanks helped her establish tumor cell lines and mouse models that mimic humans with melanoma. The mice have mutations that are present in up to 70 percent of people

with the disease—a mutation in a protein called BRAF and a deletion in a different protein known as PTEN.

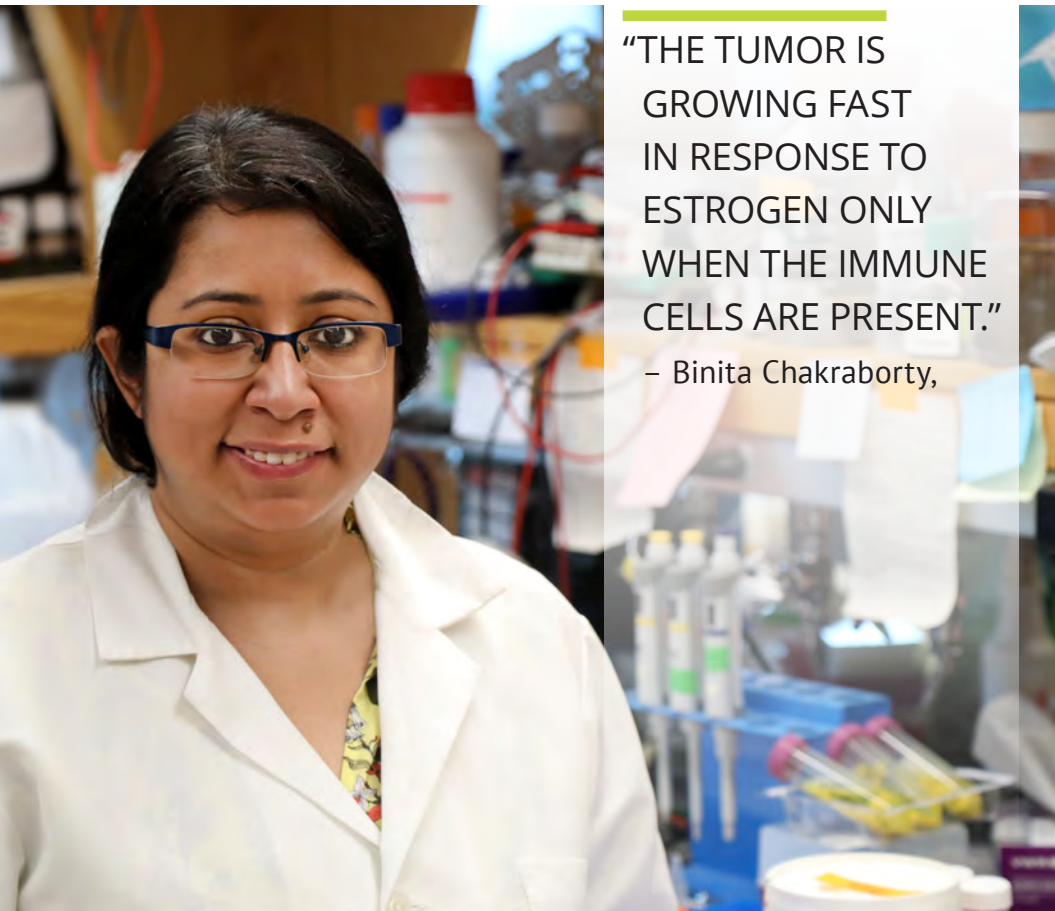
In all the tests that Chakraborty did with these mice, estrogen increased cancer growth. But not in experiments with isolated tumor cells in culture dishes.

“When we cultured the tumor cells, then put in estrogen, they were not growing faster or doing anything,” Chakraborty says. “None of these tumor cells themselves were actually responding to estrogen.”

That told her that the estrogen must be influencing something in the tumor “microenvironment” – the community of cells that surrounds the tumor and nurtures its growth. “The tumor tries to hijack the environment around it to help itself grow faster,” Chakraborty says.

To find out how estrogen is making melanoma worse, she did experiments in a mouse that doesn't have a functional immune system. In those mice, whether she treated with estrogen or not, the tumor growth stayed about the same. “That got us to hypothesize, okay, estrogen must be affecting the immune cells in the microenvironment,” she says. “The tumor is growing fast in response to estrogen only when the immune cells are present.”

The tumor microenvironment contains many different types of immune cells, but Chakraborty found that in melanoma,



“THE TUMOR IS GROWING FAST IN RESPONSE TO ESTROGEN ONLY WHEN THE IMMUNE CELLS ARE PRESENT.”

– Binita Chakraborty,

with melanoma.

So, Chakraborty did some experiments in mouse models of non-small-cell lung cancer. She found that estrogen increased “bad” macrophages in lung cancer too.

Based on these results, Antonia is now writing a clinical trial to combine a newer anti-estrogen drug used to treat breast cancer with a PD-1 inhibitor, in patients with melanoma, non-small cell lung cancer, and gastric (stomach) cancer. He hopes that inhibiting estrogen will improve patient responses to this type of immunotherapy.

“Binita is firing on all cylinders,” McDonnell says. Even while she and her husband, a scientist at UNC-Chapel Hill, juggle homeschooling their six-year-old son during the COVID-19 pandemic, she is having many of the early successes that can prepare her for becoming a faculty member. And McDonnell is thrilled. “I still get a buzz out of publishing papers, but I get a much bigger buzz out of seeing the next generation of cancer researchers succeed and get on their way,” he says.

— Angela Spivey

DISCLOSURES: Donald McDonnell, PhD, is involved in the company developing the drug that will be used in the clinical trials mentioned in this story.

estrogen particularly affects one type—macrophages. She explains that normally there is a balance between “good” macrophages, which can help alert T cells to a tumor so they can kill it, and “bad” macrophages, which help a tumor grow by promoting blood vessel growth and impairing T cell function.

In mice with melanoma, estrogen shifts the balance toward the bad macrophages. Chakraborty shared these findings

with Scott Antonia, MD, director of the Duke Cancer Institute for Cancer Immunotherapy, to get his perspective as a clinician. He was immediately interested. Unbeknownst to Chakraborty, Antonia had been studying lung cancer patients who had stopped responding to an immunotherapy called a PD-1 inhibitor. In these patients, “bad” macrophages were increased in proportion to “good” macrophages. Just like in Chakraborty’s mice

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You can make more discoveries like these possible. To donate, please visit bit.ly/dciwinter2021.

A BENCH-TO-BEDSIDE STORY

“WE’RE ALWAYS LOOKING FOR STORIES where what we do at the bench impacts what we do in the clinic,” says Donald McDonnell, PhD, coleader of the Women’s Cancer Research Program at Duke Cancer Institute. “Like one where a young graduate student finds a drug, then the drug is patented, licensed, and in a phase two trial within a matter of a couple years. You can count on one hand the number of times that happens.”

This was one of those times.

ONCE UPON A TIME, IN A LAB FAR, FAR AWAY

Four years ago, Kaitlyn Andreano, then a PhD student in the Department of Pharmacology and Cancer Biology training in McDonnell’s lab, uncovered a novel use for an old osteoporosis drug called lasofoxifene—as a possible treatment for metastatic breast cancer.

Lasofoxifene, a type of endocrine or hormonal therapy, is a selective estrogen receptor modulator (SERM). In breast cancer,

SERMs work by sitting in the estrogen receptors in breast cells, thus blocking the effects of estrogen in the breast tissue. However, paradoxically, they also function as estrogens in bone and protect against osteoporosis.

Lasofoxifene was first discovered in 1992 through a research collaboration between California-based Ligand Pharmaceuticals and Pfizer Inc. McDonnell, a young researcher with Ligand at the time, was part of the team developing the drug to treat osteoporosis in women as a result of estrogen loss in menopause.

“Estrogens are generally very protective against bone loss, but people don’t like the side effects of those drugs,” says McDonnell. “When I was a young guy with dark hair, I figured out how to manipulate the estrogen receptor to identify drugs that inhibited the negative actions of estrogen in breast cancer cells, but which were bone protective. Building on this discovery, and

BY JULIE POUCHER HARBIN



IT TAKES A VILLAGE

Some of the collaborators who have helped move lasofoxifene, a new treatment for advanced breast cancer, from the lab into clinical trials:



KAITLYN ANDREANO, PHD, graduated from Duke in May 2020 and is now a project management and clinical pharmacology specialist with Nuventra.



STEPHANIE GAILLARD, MD, PHD, is now an assistant professor of oncology with Johns Hopkins Sidney Kimmel Comprehensive Cancer Center.



DAVID PORTMAN, MD, had been principal investigator for Pfizer during some of the clinical studies of lasofoxifene in osteoporosis. His company, Sermonix, is now developing the drug for use in advanced breast cancer.

upon arriving at Duke in 1994, I set out to identify ER (estrogen receptor)-targeting drugs that worked better than those available and that would be particularly effective in the treatment of metastatic breast cancer.”

Seventy to 80 percent of the more than 270,000 invasive breast cancers diagnosed annually in women in the United States, are estrogen receptor-positive (ER+).

Endocrine therapies are standard of care for these patients. This includes SERMS (drugs in the same class as lasofoxifene) and selective estrogen receptor degraders (SERDs)—both of which target the estrogen receptor present in cancer cells and in the body’s immune cells—and aromatase inhibitors, which suppress estrogen synthesis.

More than 1.5 million women in the U.S. are currently on endocrine therapies for breast cancer—either as monotherapies or in combination with other drugs. These drugs and drug combinations have been found to work well, in some cases for many years, until they don’t.

Cancer is smart. Mutations can develop in breast cancer cells that render the best therapeutic strategies ineffective. While more and more women are living with stage 4 breast cancer (upward of 150,000), 42,000 die of metastatic breast cancer each year. Metastasis, cancer that has spread to distant organs, is the major cause of breast cancer death.

A few years ago, McDonnell explains, it became apparent to researchers across the world that estrogen receptor mutations that developed in breast cancer cells as the cancer spread—*ESR1* mutations—were one cause of this acquired resistance to endocrine therapy and a likely driver of that breast cancer spread. Upon close inspection, it was discovered that between 30 to 40% of patients with ER+ breast cancer, especially those who’d been extensively pretreated with aromatase inhibitors, would go on to develop an *ESR1* mutation.

“WE KNEW THAT IF YOU DEVELOPED AN *ESR1* MUTATION, YOU WOULD BE RESISTANT TO ALL THE ENDOCRINE THERAPIES WE HAVE, BUT LASOFOXIFENE WAS DIFFERENT.”

– Donald McDonnell

EUREKA!

In early 2016, a Duke physician-scientist who’d completed her doctoral training in



DONALD McDONNELL, PHD, leads the lab in which Andreano and Gaillard trained and is one of the inventors of lasofoxifene as treatment for advanced breast cancer.



CHING-YI CHANG, PHD, MSPH, a research associate professor in the McDonnell Laboratory, is also one of the inventors of the treatment.



SARAH SAMMONS, MD, leads the Duke arm of the international clinical trial of lasofoxifene for advanced breast cancer, which enrolled its first patient in November 2020.

ALEX BOERNER

McDonnell's lab—Stephanie Gaillard, MD, PhD—had come across an *ESR1* mutation in an ovarian cancer. Gaillard shared this with the lab, believing McDonnell might have some ideas as to how to leverage this information to help patients whose cancers harbored these mutations.

That's when Kaitlyn Andreano, the graduate student in McDonnell's lab, took on the project.

"Kaitlyn decided to collect or synthesize nearly every endocrine drug that had ever been made, which is easy enough to do in my lab because we've been involved in the development of most of them, and she screened and found that lasofoxifene alone was effective against pretty much all of the *ESR1* mutations, it didn't seem to care," says McDonnell. "We knew that if you developed an *ESR1* mutation, you would be resistant to all the endocrine therapies we have, but lasofoxifene was different."

Predicting that lasofoxifene would work in ER+ breast cancer, the lab filed what's called "an invention disclosure" on May 25, 2016.

Next, Andreano pushed for a utility patent. Without this, she and McDonnell assessed, the "old drug" would never be developed. Because the discovery was made in a Duke lab, Duke University filed, in October 2017, a utility patent for the use of lasofoxifene to treat ER+ breast cancer. The patent was issued in April 2019 with Andreano, Ching-Yi Chang, PhD,

MSPH (research associate professor of pharmacology and cancer biology), Gaillard, and McDonnell listed as inventors. Lasofoxifene looked promising—where other endocrine therapies had failed—for the treatment of metastatic breast cancer in patients with the *ESR1* mutation. Next, to translate these findings in the lab to clinical use.

The owner of the U.S. rights to lasofoxifene at the time was Ohio-based Sermonix Pharmaceuticals. The company's CEO, David Portman, MD, had acquired the rights to the drug in February 2015, just a couple months after he and his wife Miriam Davidson Portman, MD, founded the company.

Portman—an OB-GYN by training and clinical researcher in women's health, sexual medicine and menopause—had been principal investigator for Pfizer during some of their phase two and phase three studies of lasofoxifene in osteoporosis. He'd also consulted on the drug's gynecological effects, including the alleviation of vaginal dryness/atrophy in menopause that can cause painful intercourse and sexual dysfunction.

"This particular compound was looking for a good home," says Portman. "We were fully prepared to try to move it forward in what had already been studied in menopause and osteoporosis, to pick up where Pfizer left off." But then they came across the invention disclosure filed by the McDonnell lab. "This seemed to be a much more important area of unmet medical

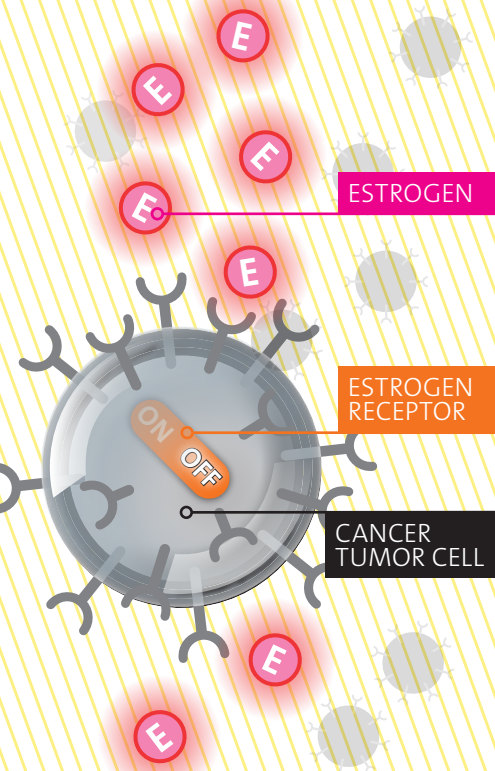
HOW LASOFOXIFENE STOPS CANCERS

Out of all breast cancers, 70 to 80 percent have receptors for the hormone estrogen (estrogen-receptor positive). Estrogens can fit into the receptor and promote tumor growth and metastasis.

To reduce tumor growth, patients are prescribed drugs that inhibit the activity of the estrogen receptor.

Unfortunately, in advanced disease the estrogen receptor in the cancer cell can mutate, making these drugs ineffective (an *ESR1* mutation).

In tests in the lab, even when those other drugs won't work, lasofoxifene "turns off" or inactivates the estrogen receptor in breast cancer cells. Thus, in animal models, the drug reduces tumors and metastasis.



Lasofoxifene was initially developed for the treatment of osteoporosis and vaginal atrophy.

Now clinical trials are testing it as a treatment for advanced or metastatic breast cancer that has failed standard of care therapy. The first site of the trial opened in Rochester, Minnesota in 2019. Duke Cancer Institute opened its site of the trial in November 2020.

DAVID PRICKEL

“TREATING METASTATIC BREAST CANCER PATIENTS IS MY PASSION. PROVIDING THEM THE MOST UP TO DATE AND COMPASSIONATE CARE AND DEVELOPING NOVEL THERAPIES FOR ADVANCED BREAST CANCER THAT WILL IMPROVE OUTCOMES ARE REALLY WHY I AM HERE AT DUKE.”

– Sarah Sammons

need. We had no idea, when we started, that we'd end up in the metastatic breast cancer space.”

On November 8, 2016, even before a patent was issued, Sermonix and Duke's Office of Licensing and Ventures came to an agreement whereby the company would acquire exclusive rights to further develop what was Duke's intellectual property. If the Food and Drug Administration (FDA) approved the drug, Sermonix would commercialize lasofoxifene to treat advanced and metastatic breast cancer.

Sermonix also expanded its agreement with Ligand from U.S. rights to worldwide licensing rights, clearing the way for a launch of an international multi-site clinical trial “Evaluating LAsofoXIfeNe in ESR 1 Mutations,” the ELAINE Study, named for Portman's sister-in-law Elaine Davidson Nemzer, MD, a child psychiatrist who passed away from metastatic breast cancer 20 years previous at the age of 47.

ON TRACK

The ELAINE Study opened last year—enrolling its first patient in September 2019 at the Mayo Clinic in Rochester, Minnesota—as a phase two open-label study with Fast Track designation by the FDA. (There was no need for a phase one trial since dosing and safety were already evaluated in the studies of lasofoxifene for osteoporosis.)

The trial compares lasofoxifene to fulvestrant, a current treatment for metastatic breast cancer, in postmeno-

pausal women and premenopausal women with locally advanced or metastatic ER-positive breast cancer and an *ESR1* mutation whose disease has progressed despite treatment with the standard-of-care therapy.

Duke Cancer Institute opened a study site in September 2020 and enrolled its first patient on November 9, 2020, with DCI medical oncologist Sarah Sammons, MD, as the clinical principal investigator.

The company's goal, Portman said, is to fully enroll the study (100 patients) by early 2021 and have phase two results data to report by early 2022.

Every patient at the trial sites who meets the criteria will have the chance to be screened for the trial. “A nice thing about this trial is that we're able to utilize the strength of our molecular tumor board,” says Sammons, who hopes to accrue up to 10 patients. “When patients get genomic sequencing as standard of care, MrT (DCI's in-house electronic Molecular Registry of Tumors) will flag patients who have an *ESR1* mutation and automatically email/notify the provider of their possible eligibility.”

ADDED BONUS

Often, when patients enroll in a trial, they have little information about the drug's potential side effects. In the case of lasofoxifene, its side effects are well characterized and appear to be quite well tolerated.

“Lasofoxifene is very patient friendly,” Sammons says. “It actually improves

COUNTING ON A CURE

vaginal dryness and sexual health, and strengthens bone.”

If the trial yields positive results, the next step will be to combine lasofoxifene with other targeted agents, Sammons says. “Endocrine therapy is the important backbone. We know that endocrine therapy works better, in general, when you add an optimal targeted agent such as CDK4/6, mTOR, or PIK3CA inhibitors.”

This bench-to-bedside story has been written, but it’s not finished. McDonnell and Sammons, for the sake of the thousands of metastatic breast cancer patients waiting for their next line of therapy, hope there will be a happy ending.

“Treating metastatic breast cancer patients is my passion,” says Sammons. “Providing them the most up-to-date and compassionate care and developing novel therapies for advanced breast cancer that will improve outcomes are really why I am here at Duke.”

For more information about the ELAINE trial and enrollment at Duke Cancer Institute, contact the Breast Oncology Research team at 919-660-1278.

DISCLOSURES:

Sarah Sammons, MD, has done consulting for Novartis, Foundation Medicine, Sermionix, Astra Zeneca and Daiichi Sankyo. She receives research funding to her institution for clinical trials from Astra Zeneca, BMS, Eli Lilly, and Sermonix.

Donald McDonnell, PhD, is a consultant and has stock ownership in G1 Therapeutics and Zentalis. He receives royalties from Radius Health and could receive royalties through Duke associated with the licensing of lasofoxifene. He receives research support from Novartis.

Kaitlyn Andreano, PhD, Stephanie Gaillard, MD, PhD, and Ching-Yi Chang, PhD, could receive royalties through Duke associated with the licensing of lasofoxifene.

After a diagnosis in 2011 of metastatic breast cancer—cancer that has spread beyond the breast and to distant organs—Katrina Cooke has already had many more years with her two sons—now 12 and 14—than she ever thought possible.

When she was diagnosed, the statistics she read told her that most people with her diagnosis live only an additional year or two. But a combination of treatments, including surgery, targeted treatments like herceptin, and anti-estrogen therapies, worked for her. In December 2012, she was declared to have “no evidence of disease.”

While experiencing many ups and downs since then, she has used that “extra time” to become a professional speaker, peer mentor, and advocate. She became a peer mentor with the American Cancer Society and in 2017 joined the Duke Cancer



JULIE HARBIN

Katrina Cooke and her sons, Logan and Camden, at her 140th infusion treatment.

Institute Oncology Patient Advisory Council (OPAC), a volunteer program that gives Duke cancer patients and their caregivers an opportunity to provide their perspective on the patient experience and offer recommendations on how to enhance it. Since 2018, she’s served as community co-chair of the group.

In June of 2020, a spot was found on her rib. Bone can be tricky to biopsy, making bone metastasis difficult to confirm.

She is working with Duke interventional radiologist Alan Sag, MD, and medical oncologist Kelly Marcom, MD, on further diagnosis and treatment.

“Research is the only thing that will keep me alive,” says Cooke. “Eventually, I will run out of options and that will be it. We have to do what it takes to save my life. My boys need their mom.”

— Julie Poucher Harbin

“WE HAVE TO DO WHAT IT TAKES TO SAVE MY LIFE. MY BOYS NEED THEIR MOM.”

– Katrina Cooke



KEN HUTH

Fighting on Both Sides of Cancer Care

For 27 years, Heather Paradis, a 1995 graduate of Duke University's Master of Science in Nursing Program, cared for cancer patients at Duke University Hospital as a hematology-oncology nurse practitioner. As she saw many patients fighting the disease, she had no idea that she would one day be on the other side of cancer care.

What she learned when she visited that other side is now helping others who have been touched by cancer.

In September 2016, Paradis' husband of two years, Eric Paradis, went for his annual physical and had routine blood tests. The results indicated an elevated white cell count. "At first we thought it was just a reaction to poison ivy exposure, because Eric had cleared the area on which we started building our new house," Heather says.

Eric, the owner of a successful drywall company, repeated the blood tests, and the results again showed an elevated white cell count and low hemoglobin levels. Heather, who worked with patients with blood cancers, decided to look

at the trend of his white cell count over the years. "I knew what it was just by looking at his labs," she says. "His monocytes had been elevated for several years. I realized that he had chronic myelomonocytic leukemia."

Eric was referred to Murat Osman Arcasoy, MD, professor of medicine, for further diagnosis, who confirmed what Heather already knew. "He said: 'I'm sorry,' and I started crying," she says.

Arcasoy recommended a bone marrow transplant, and Eric's sister was found to be a matching donor. Eric did not need to start the treatment immediately, and he and Heather decided to finish building their house before scheduling the transplant.

In March 2017, six weeks before completing the house, Eric's white cell count started going up, and a bone marrow biopsy showed that his disease had changed to acute leukemia, which required him to go through an immediate chemotherapy treatment to put the disease into remission. After the treatment, they completed the house and moved in the first weekend of May.

A week later, Eric started the bone marrow transplant. Heather is grateful for a Duke

BY
ALIZA
INBARI

research study, led by Anthony “Tony” D. Sung, MD, which allowed Eric to have the transplant on an outpatient basis. The study investigated whether at-home care for stem-cell transplant patients would reduce infections and normalize their microbiome (the population of bacteria that inhabit the body.) (See “A Call to Respond to COVID-19” on page 3.) “We could stay in our brand-new house and enjoy it,” Heather says.

Unfortunately, Eric developed graft-versus-host disease, in which donor bone marrow or stem cells attack the recipient, and things got more complicated. In January 2018, Heather retired from Duke to focus on her husband's treatment and to spend more time with him. “The wife in me wanted to be optimistic and hopeful, but the medical component of me knew we were in big trouble,” Heather says. In October 2018, after more than two years of battling leukemia, Eric succumbed to the disease.

EMOTIONAL SUPPORT

A month before Eric passed away, Heather met for lunch with a friend, and they talked about therapy. Heather knew about the Duke Cancer Patient Support Program (DCPSP) and had recommended it to patients when she was working. DCPSP offers free counseling sessions to cancer patients and their family members. At the time, the program had only two clinical psychology interns who covered the needs of all Duke cancer patients. Heather started seeing a therapist, and later Eric attended counseling with the other intern. “It helped us talk more and be honest with each other about the fact that we were scared and that Eric was afraid he was going to die,” Heather says.

In Eric's memory, Heather decided to give back to the program that helped her during the toughest time in her life. In 2019, she established the Heather and Eric Paradis Cancer Support Fund, an endowment that supports an additional clinical psychology intern at DCPSP. Today, the program has three interns that rotate every year.

“We are so thankful for Heather's gift,” says Tamara Somers, PhD, associate professor in psychiatry and behavioral sciences and co-director of the Cancer Behavioral Management and Support Clinic rotation, which trains the interns who work with the support program. “It has allowed us to add a third intern to the clinic who is dedicated to bone marrow transplant patients and

their families, and we have been able to increase our services to this group and across the cancer center.”

Heather hopes that in addition to supporting patients and family members, the intern will support staff members who care for patients. “When I started talking with a therapist, I not only dealt with the fact I was losing my husband. I also dealt with all the grief that I had from losing patients that I never really dealt with before.” Somers says that she hopes to be able to provide support to staff members through mindfulness and relaxation

activities in the future, under the guidance of the clinical psychology intern.

Heather has also made a bequest commitment that will provide additional support to the DCPSP, the Duke Hematologic Malignancies and Cellular Therapy Program, and Duke Athletics.

In addition to providing financial resources, Heather volunteers as a member of the Duke Oncology Patient Advisory Council, which works to improve the patient experience. The council created a Duke Cancer Center Survivorship Day event that is held yearly, developed a distress screening process for patients, and more. Heather provided her input on the revised patient resource booklet that DCPSP hands out to new patients and reviewed the content of new questionnaires for patients. She is also on the board of the Duke Cancer Institute Supportive Care and Survivorship Center. “The ability to use my knowledge and experience working with Eric to continue to help people gives purpose and meaning to my life,” she says.

Last year, around Eric's birthday in November, Heather hosted a fundraising event for the Duke Cancer Institute Supportive Care and Survivorship Center at her home. In 2020, due to COVID-19, she hosted it via Zoom video conferencing. “It's a way to remind us of Eric and support the center,” she says.

“THE WIFE IN ME WANTED TO BE OPTIMISTIC AND HOPEFUL, BUT THE MEDICAL COMPONENT OF ME KNEW WE WERE IN BIG TROUBLE.”

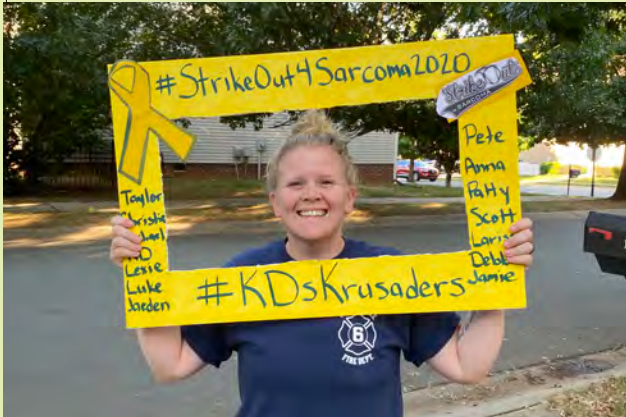
– Heather Paradis



Heather Paradis and her late husband, Eric, at a Duke football game.

YOU CAN HELP

To donate, visit bit.ly/celebrationeric



☰ The Duke Cancer Institute multidisciplinary Sarcoma Disease Group raised more than **\$47,000** for sarcoma research at its **11th Annual Strike out for Sarcoma 5K and Family Fun Walk**, held September 12 and 13. The event was virtual because of the COVID-19 pandemic, but 23 teams and 192 participants shared photos of their separate walks and runs for the cause. Organizers helped everyone warm up ahead of the event with online Zumba and stretching sessions. Pictured is Taylor Burton, part of team KD's Krusaders, organized by Christie Burton to honor her sister, sarcoma survivor KD Lanning.

A Virtual All Star Lacrosse Team

☰ **OF ALL THE HIGHLIGHTS OF HIS DAYS AT DUKE**—majoring in engineering, serving in the Air Force ROTC, and playing lacrosse as captain of the 1985 varsity team—1985 graduate Jeff Spear says his experience with Duke lacrosse and then-coach Tony Cullen had one of the biggest impacts. “Tony had very high standards, and he inspired everyone to excellence,” says Spear, a retired Air Force pilot who now coaches lacrosse for Leesville High School in Raleigh, North Carolina. When Cullen passed away from cancer in 2002, former players founded the North Carolina High School Athletic Association Tony Cullen Memorial Scholarship Fund. In 2017, Spear and another lacrosse coach, Franklin Zirkle, decided to create an annual event to more fully fund the scholarship.

They decided to also raise support for Duke Cancer Institute, where Cullen had been treated. Each year, the group chooses the Bull City All

☰ **TEE OFF VS. CANCER** raised **\$81,920** for Duke cancer research with their second annual golf tournament. The event was organized by 1979 Duke University graduate and Duke Cancer Institute board of advisors member Rick Geiryn, and 1979 Duke graduate and emeritus board of advisors member Michael Fields.



TRIANGLE EXPOSED

Stars—a women’s and men’s all-star team made up of high school lacrosse players from all across the state of North Carolina. The players are thrilled to play the **Cullen Classic for Cancer** in Duke’s Koskinen Stadium, home of the Duke varsity lacrosse team. A portion of the ticket sales funds the scholarship and a donation to Duke Cancer Institute (DCI). In 2020, the COVID-19 pandemic meant no game, and no ticket proceeds. But the group still chose all-star teams to honor the players. And, they managed to raise **\$1,500** for DCI, bringing their total raised for cancer research over four years to \$9,143.



A Constant Presence

In 2016, Duke employee Brandy Chieco was a new mom with a three-month-old baby boy when her own mom, Brenda Brooks, was diagnosed with synovial sarcoma, which tends to arise in the joints.

Brooks spent two years receiving treatment from a team of doctors at Duke Cancer Institute (DCI). "The team were just so amazing and supportive," Chieco says. "They did everything they could."

But Chieco's mom passed away from the disease on February 23, 2018, just two days after Chieco's birthday.

"She was my everything," Chieco says. She and her mom shared a love of music, and they attended a concert together just a few months before her mom died. "The cancer was in her hip," Chieco says. "She couldn't stand for

very long, but we still had a great time. I remember thinking that I needed to soak up every moment, because I just knew we wouldn't have that again."

"I would never wish for anyone to have to see someone that they love so deeply go through something so horrible," Chieco says. "But at the same time, those two years were transformative for me. I learned so much from her about strength and resilience in that time, and it made me who I am now."

Just like the doctors at Duke were there for her mom, Chieco now wants to be there for others who will face the same disease.

"Sarcomas are so rare, and it's such

an aggressive form of cancer," she says. "There's so much research that still needs to be done to understand it. The only thing I could think to do to help heal my own pain and honor my mom was to give back in some small way because no one should have to go through what she went through."

Chieco's support is a constant for DCI because she gives monthly through the Hero for Hope program. "I feel a very, very deep connection to Duke now, more than ever before," she says.

"There's so much research that still needs to be done to understand it. The only thing I could think to do to help heal my own pain and honor my mom was to give back in some small way..."

As a **Hero for Hope**, you provide reliable, monthly support. Your monthly gift is automatically charged to your credit card or deducted from your checking account.

To learn more about becoming a Hero for Hope for Duke Cancer Institute, email dcidevelopment@duke.edu or call 919-385-3120. Visit bit.ly/DCIhero to give online.



YOU CAN SUPPORT THE FIGHT

Gifts to Duke Cancer Institute help us develop new treatments and provide compassionate care. To make a gift, visit bit.ly/dciwinter2021. Thanks for your support!

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GET MOVING FOR DCI

Resolving to exercise more in the New Year? Challenge yourself to walk, run, or ride to fight cancer!

Sign up to create your own **I Move for DCI** virtual event and fundraiser to support research at Duke Cancer Institute. It's simple:

▶ Set a goal for how long and when you will walk, run, or ride. Create an online

giving page and let your friends and family know you are fundraising to support Duke Cancer Institute's research.

Whether you walk, run, or ride 100 yards or 100 miles, we are all 100% behind Duke Cancer Institute. Join us as we move toward a cure!

Visit imovefordci.org to get started.