BEARDOWN BEAT CANCER

UACC is the only cancer center headquartered in Arizona, and currently is one of only 49 in the nation, to earn the National Cancer Institute’s Comprehensive Cancer Center designation, which demonstrates our scientific leadership, the breadth and depth of our research, and the spirit of collaboration we nurture among scientists. As a leader in the national dialogue on cancer, UACC is initiating rapid advances in research and patients’ health.

› We’re training the next generation of scientists and physicians to take on cancer.
› We’re leading initiatives that reduce cancer health disparities in underserved populations in our state.
› We’re inspired by our patients, every day, to build a better future.

We're inspired by our patients, every day, to build a better future.
At the University of Arizona, we are taking bold approaches to our greatest challenges. At the Cancer Center, our scientists, physicians, researchers, nurses and staff are committed to one thing — to prevent and cure cancer.

For more information on how you can make a difference and support cancer research, please contact the UA Cancer Center Development Office at 520-626-5752, toll-free at 877-518-4638, or give@uahs.arizona.edu

The Phase I Program at the UA Cancer Center provides cutting-edge care to patients whose cancer has progressed on standard chemotherapy. Patients in phase I clinical trials receive full genetic profiling of their tumors, in addition to comprehensive and unique care focused on cancer treatment, nutrition, optimal physical activity, and mental health wellbeing through diverse specialists and support groups.
A NOTE TO OUR FRIENDS AND SUPPORTERS

Monumental advances have been made in cancer research and treatment over the last few decades. The University of Arizona Cancer Center (UACC) has been at the forefront of these innovations from the beginning, reducing the rate of specific cancers and helping patients live longer, healthier lives.

But we still have a long way to go. Cancer is Arizona’s greatest killer with more than 12,000 deaths and 32,000 new diagnoses each year. Almost every resident has been affected by cancer either directly or via the diagnosis of a friend, relative, spouse, child or parent. Advances have occurred, but now we need to take a giant leap forward toward the cure for all cancers.

Science and technology have transformed the fight against cancer. We have developed new technologies that are changing the way we treat patients and conduct research, and new science has driven the ability to make progress in specific diseases. For example, by combining highly personalized immunotherapy and chemotherapy, we are developing a simple blood test for the early diagnosis of sarcoma, as well as a genetic test to predict who is at risk for recurrence and who can be cured by local therapy.

Lifesaving medical advances like these are made possible by generous support for the breakthrough research happening at the UA Cancer Center.

You can make a difference. You can change one person’s life — or thousands.

Your support accelerates the process of discovery, from the laboratory bench to a patient’s bedside. Let’s tackle cancer together.

At the UA Cancer Center, we want to partner with all stakeholders to lead the way in our fight against cancer. For our part, we are committed to developing novel cancer-fighting agents in the laboratory and focused on developing technologies, including unique genomic analysis and immunotherapy for our patients.

This will be a challenging effort, but the reward for those we love and all those whose lives we can affect will be well worth the fight.

We cannot thank you enough for your generous support. What we can do is double down on our efforts and do all that we can to make sure that your investment is supporting research that will save lives.

Sincerely,

Andrew S. Kraft, MD
Sydney E. Salmon Endowed Chair
Director, University of Arizona Cancer Center
Associate Vice President, Oncology Programs, University of Arizona Health Sciences
Senior Associate Dean for Translational Research, UA College of Medicine – Tucson
“The privilege of being an oncologist is being a true partner in my patient’s journey.”

– Julie Bauman, MD, MPH
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Dr. Julie Bauman with her mother, Dr. Kay Bauman.
The Bauman name has been a part of the University of Arizona’s story for more than a generation. Hanging on a wall at the UA Cancer Center is a plaque that reads, “In memory of James K. Bauman, MD, a gift from his family.” It has been housed here since the Sydney E. Salmon building first opened in 1998.

Julie E. Bauman, MD, MPH, joined UACC in September 2016 as associate director of translational research and division chief of hematology and oncology at the UA College of Medicine – Tucson. Other faculty members were excited to welcome her to the UA, as she brought so many talents, accomplishments and passions to the table. Dr. Bauman has participated in groundbreaking clinical trials, advocated avidly for cancer prevention and is even named on a patent for a method to treat infection with human papillomavirus.

But, unlike some newcomers to Tucson, Dr. Bauman didn’t need to develop a tolerance for three-digit heat, get into the habit of drinking twice as much water as what seemed normal or learn to stay out of striking distance of a jumping cholla. As a Southwest native, those things already came naturally.

While Dr. Bauman’s birthplace, an Inuit village in Bethel, Alaska, was about as dissimilar to Tucson as it gets, her parents’ medical careers brought them from a post at the Indian Health Service in Alaska to work with migrant farmworkers in the Southwest — first in Phoenix, then to Southern Texas and finally to Tucson when Dr. Bauman was in the seventh grade.

Her parents’ love of nature gave form to many of her childhood memories.

“I was raised camping,” Dr. Bauman recalls. “I spent my childhood summers camping all over the Four Corner states. The Southwestern landscape is my spiritual home. I look at the Catalina Mountains, and I just relax and feel centered. I call the Catalinas my true north.”

To Cooler Climes and Back

In 1985, Dr. Bauman graduated from Salpointe Catholic High School. She received her bachelor’s degree from
Eastern Michigan University before earning a dual MD/MPH from Tufts University outside Boston. This foray out of the Southwest, into vastly different climates, delivered a surprising cultural shock to her system.

“The light of the Southwest — I didn’t know at the time how dependent I was on it for health and a sense of place and space,” she remembers, reflecting on her early college years in the Midwest.

Dr. Bauman’s career trajectory is impressive. Her CV is festooned with awards, publications, mentorship roles, research grants and leadership positions with the National Cancer Institute. Her career brought her from a residency in Utah to a fellowship in Seattle, and to professorships in New Mexico and Pennsylvania. It was at the University of Washington that she homed in on head and neck cancer as a specialty.

“Head and neck cancer affects vital functions so critical to our humanity: facial expression, speaking, eating, breathing,” she says. “I became passionate not just about improving treatments for people with head and neck cancer, where science has delivered so many recent successes, but about improving all elements of survivorship. I became increasingly specialized, and when I moved to Pittsburgh I exclusively focused on head and neck cancer research.”

But Tucson beckoned. While she had previously interviewed for a couple of other positions at UA Cancer Center, “the time was never quite right,” she says.

“I was at the University of Pittsburgh, and I had really followed my academic passions, making progress in head and neck cancer, immunotherapy and chemoprevention research. The University of Pittsburgh is one of the international leaders in head and neck cancer research, and was an amazing place for my academic development,” Dr. Bauman recalls. “However, my personal sense of place and space was never comfortable there.”

Luckily, an opportunity to return to Tucson fell into her lap.

“I was invited to apply for the division chief position in my hometown, and it turned my head for a lot of reasons,” Dr. Bauman recalls. “My mother is still here, my sister is here, my roots are here.”

It wasn’t just her family or the light and landscape of her youth that made Dr. Bauman feel at home. Tucson’s people also are an important aspect of what makes the city so special.

“The openness of people to one another is very different in the West,” Dr. Bauman says. “I went to medical school in Boston. Most recently, I was at the University of Pittsburgh. What I love about the University of Arizona is that there is a really amazing set of accomplished, brilliant scientific minds here and yet the spirit of interaction is so collaborative. Physicians and scientists are every bit as accomplished and yet, in my view, much more humble and open.”

While her work as a researcher and oncologist keeps her busy, she still enjoys spending time outdoors, hiking, swimming and cycling. Most recently, she has taken up taekwondo with her family. Another hobby is the study of the world’s religions, which enables her to connect to patients across the spectrum of spiritual traditions.

“One of the things that I love about being an oncologist is that we’re in people’s lives at a time when their spirituality and their sense of meaning is really challenged,” she says. “I really love to engage my patients at that level.”

**A More Meaningful Homecoming**

Dr. Bauman’s Tucson homecoming wasn’t just an opportunity to unite her three children and husband with her mother and sister. It also was an opportunity for a unique reunion with her father, who passed away suddenly when she was 16 years old.

“My dad was an ob/gyn here in Tucson,” Dr. Bauman recalls. “My mom really wanted to create a way of memorializing him as a physician, and wanted us to have a way of seeing him memorialized.”

The construction of the UA Cancer Center’s Salmon building on the UA campus presented an opportunity for this memorial, and Dr. Bauman’s mother made a donation to the Cancer Center, memorializing James K. Bauman, MD, with a plaque that hung on the new building’s wall.
When Dr. Bauman started working here, she looked for that plaque, but couldn’t find it. Unbeknownst to her, however, Chad Adams, the assistant director of cancer clinical research, and Elik Essif, the UA Cancer Center facilities coordinator, had hatched a plan.

“When Dr. Bauman was interviewing here, I asked her if there was any relation to the Bauman name that I had seen on the wall,” Mr. Adams says. “She told me that was her father, and when we got to speaking about her family, both parents being physicians, and her mother practicing medicine at the UA, you could tell just how much her parents meant to her. Elik and I wanted Dr. Bauman to be able to see it every day and feel at home.”

Mr. Essif located the plaque and carefully moved it from its previous location on the second floor to Dr. Bauman’s office.

“One day I came to work, a few months after I’d started, and the facilities manager had found it and had moved it to above my door,” Dr. Bauman recalls. “When I walked in, there it was, right above my own name as if it had always been there. I took a picture and texted it to my mother, and it was very moving to her.”

Dr. Bauman now can reach out and touch that plaque every time she enters her office, bringing back her father’s memory and reinforcing the lifelong connection she has with Tucson and the University of Arizona.

“I hope it provides her with inspiration every time she walks into her office,” says Mr. Adams.

Her commitment to providing care to people with cancer is just as strong as her love for Tucson.

“What gets me out of bed every day? My patients,” says Dr. Bauman. “It’s being a part of a person’s life when they’re going through something this important. It is remarkable to me how the diagnosis of cancer helps people to marshal their strength, focus on what’s truly meaningful and really participate in their own treatment — even the decision to stop treatment. The privilege of being an oncologist is being a true partner in my patient’s journey.”
“Goin’ Out West”

The UA Cancer Center’s Deputy Director Has Big Plans for Phoenix, Arizona and Beyond

by Cody Cassidy

Talking to us on a hot June day from his office at the University of Arizona Cancer Center at Dignity Health St. Joseph’s Hospital and Medical Center, William Cance, MD, couldn’t help but bring up the heat. It was 108 degrees with clear skies and a lot of sun outside in downtown Phoenix. At the same time, in Buffalo, New York, where he lived a year earlier, it was ... 66 degrees and partly cloudy.

Dr. Cance, a renowned oncology surgeon and physician-scientist, joined the UA Cancer Center in October 2016 as deputy director to lead clinical and research efforts in Phoenix. He hit the ground running, quickly getting a feel for the complex landscape of both the University of Arizona as well as the biomedical and health-care fields in the state.

Dr. Cance is a fellowship-trained surgical oncologist and is chiefly interested in developing innovative cancer programs and new cancer therapies. His research interests are centered on focal adhesion kinase (FAK), a critical survival signal in cancer cells and a promising therapeutic target being evaluated in several clinical trials using FAK inhibitors. He was the first researcher to identify and clone human FAK in 1993 and demonstrate its overexpression in almost all human cancers. Today, Dr. Cance is homing in on the biology of FAK and developing anti-cancer drugs that target the signal. He also is interested in the biological role of FAK in enhancing the survival of cancer cells.

Dr. Cance wasn’t just taken aback by Arizona’s hot weather, but also by its significance as a hotbed of medical research in the Southwest. He hopes to harness the energy radiating from Phoenix and Tucson to advance cancer research regionally and beyond.

“Partnerships with private industry, nonprofits, with the community physicians and community-based health-care systems are a top priority for the cancer centers and the National Cancer Institute,” Dr. Cance says. “I see tremendous potential, particularly with the great clinical volumes that are in Phoenix as well as the expansion of the service area — the Mexican-American and Native-American populations.”

Arizona draws “medical tourists” from around the world to some of the best clinical and research facilities in the nation, including the University of Arizona and Arizona State University, the Translational Genomics Research Institute (TGen), the Barrow Neurological Institute, Mayo Clinic and
Norton Thoracic Institute. Dr. Cance aims to bring them all together in the name of cancer research and care in a series of public-private partnerships with the UA Cancer Center at the hub.

“The problem is, I believe cancer research is somewhat in the doldrums in many respects because many people want to have their own empire,” says Dr. Cance, speaking to the importance of collaboration among researchers. “I’m trying to build bridges and bring larger groups of people together, because I believe you can attack the problem more broadly with a bigger team. Cancer is just too big for one individual, for one institution.”

Dr. Cance spent the better part of his first 12 months at the UA Cancer Center establishing relationships and working with Dignity Health St. Joseph’s Hospital and Medical Center to get the UA Cancer Center in Phoenix better established and more widely recognized. The new facility, the UA Cancer Center at Dignity Health St. Joseph’s Hospital and Medical Center, is a 220,000-square-foot outpatient clinic and research building on the UA biomedical campus in downtown Phoenix. Patients began going there in August 2015.

**His Efforts in His First Year Have Been Fruitful.**

“I have seen a lot of enthusiasm on all sides for the potential for working together, from Dignity St. Joseph’s to Norton Thoracic Institute and the Barrow Neurological Institute. The incoming chief of Barrow wants to collaborate. The incoming scientists at the Norton are all becoming faculty and joining the UA Cancer Center. We are working with TGen and Arizona State, collaborating with them on their existing drug discovery approaches,” Dr. Cance says.

Dr. Cance elaborates on the process for fostering increased collaboration: “The first step is to build those relationships and find out where the synergies and shared interests are. It’s kind of like trying to put together a big program project grant or a SPORE (Specialized Programs of Research Excellence) grant, trying to find all the areas where there is the commitment and the interest.”

“Step two is integrating within the comprehensive cancer center realm in providing value to these groups through the Cancer Center,” Dr. Cance continues. “I believe you have to do that to move things forward. And once you do that, you need to have metrics, which will be clinical trial accruals, investigator-initiated trials, new grants and so forth.”

**And as for Year Two?**

“This process is a continuum,” Dr. Cance tells us. “We can’t just say, ‘This is a really cool collaboration. Look at this. This is really good.’ We need to show how it works. The challenge next year will be integration with the UA Cancer Center research programs and the disease teams. So that’s the big challenge for the next year.”

For example, Dr. Cance is teaming up with James Spivey, MD, new chair of internal medicine at Dignity Health St. Joseph’s, to lead a multidisciplinary effort in hepatocellular carcinoma that pulls from existing strengths of the clinical and surgical expertise of physicians and surgeons at St. Joseph’s. The idea is to connect them with people like the UA Cancer Center’s Peter Lance, MD, FRCP, and his outreach programs with the Navajo, who are disproportionately affected by liver cancer.

“Another thing that I want to do next year is put some ‘meat’ around the investigator-initiated trials,” Dr. Cance says. Investigator-initiated trials (IITs) are developed and executed by research institutions, such as UA Cancer Center, rather than pharmaceutical companies, and are integral to the bench-to-bedside translational research that is a key characteristic of comprehensive cancer centers.

“I have been very impressed with the concepts for IITs that we have in Phoenix,” Dr. Cance continues. “We just met with Alan Nelson, the CEO of VisionGate, who is developing technology used for diagnosing lung cancer out of sputum samples. We want to partner with them in this and other areas to bring their new technology into our clinical research efforts.”

Dr. Cance concludes with his goals for expanding the Cancer Center’s reach into the larger research community: “I believe we really need to incorporate industry and the entrepreneurial side into our collaborations. There is a lot of evolution. And I love to put people together like that. The public-private partnerships are what I think we have to do more of.”
An avid researcher, Dr. Cance is the principal investigator on a 25-year R01 grant from the National Cancer Institute (NCI) focusing on focal adhesion kinase (FAK). He has been awarded numerous other grants from the NCI and National Institutes of Health, as well as the American Cancer Society, Susan G. Komen Breast Cancer Foundation and the U.S. Department of Defense.

Dr. Cance received his medical degree from Duke University School of Medicine and was the chief resident in the Department of Surgery at Barnes Hospital Washington University School of Medicine in St. Louis. He also completed two fellowships, one in surgical oncology at Memorial Sloan-Kettering Cancer Center in New York and the other in the Departments of Surgery and Microbiology and Immunology at Washington University School of Medicine. Dr. Cance holds eight U.S. patents, including a patent for kinase protein binding inhibitors and one for devices and methods for implementing endoscopic surgical procedures and instruments within a virtual environment. He also has four patents pending.

Dr. Cance is past president of the Society of Surgical Oncology, and a member of the American Association of Endocrine Surgeons, American Association for Cancer Research, American Surgical Association, Society of Clinical Surgery and American Society of Clinical Oncology, as well as a Fellow of the American College of Surgeons. In addition, he served on the editorial boards of the *Annals of Surgical Oncology* and the *Journal of Clinical Oncology*. He also served on the Board of Scientific Counselors of the National Cancer Institute.

He is author of more than 130 peer-reviewed publications and 10 book chapters and is founding editor in chief of the Society of Surgical Oncology-branded database of Complex General Surgical Oncology.
What is life like in Phoenix and the Valley of the Sun for you?

My wife and I love it! It is such a livable city and it’s great to have all of the amenities of a city. We live in central Phoenix and are really enjoying everything Phoenix has to offer.

What are some of the things that you’ve discovered that you like to do in the Phoenix area, or Arizona in general?

There are two tomato seasons for my garden. The spring and the fall. I don’t think I’ve ever had two tomato seasons in the same year, so I’m really excited about that. You can plant your fall tomatoes and you can plant your spring tomatoes. It’s great!

We love the proximity of the outdoors and the fact that it’s available all year. As Dr. Andrew Kraft said when I was going through my recruitment here, “Arizona has everything you want, you just have to get to the right altitude.”

Dr. Cance and his wife Jenn hiking in the Phoenix Mountain Preserve on Christmas Day 2016.
We are really loving the diversity of Arizona and the fact that you can experience everything in just a short drive.

The summer is a good time for grant-writing, which is the reverse of everywhere I have lived. In Buffalo, you were stuck inside for six months during the winter so you did your grant-writing then. Here, you have three months where you get up early, get your outdoor activities in and then, during the day, it’s a great time for grant-writing.

In all honesty, how do you feel about the heat? Honestly!

Honestly, the 118-degree days are tough. My tomatoes don’t like it either. I had to get a sun cloth for them yesterday. But you know, by getting up early, it really just doesn’t bother us. You get up early when it’s the coolest and then you find other stuff to do during the heat of the day. We still go to the club and work out. I haven’t been to a Diamondbacks game yet in this heat.

They can close the roof to the stadium so the experience is entirely climate-controlled.

I didn’t know that! OK, cool!

Did you go to the Waste Management Phoenix Open?

No, I was too scared of the crowd. Is it good? I’ll have to check that out next year.

Favorite Arizona sports team?

The Diamondbacks are my favorite team because they support the UA Cancer Center.

Favorite restaurant?

Matt’s Big Breakfast would definitely be my favorite. For dinner, there are so many great places, it would be hard to pick just one, but I would say The Gladly, Dieci and L’Amore.
taking the fight to the molecular level:

THE HUMAN GENOME IS OUR GREATEST WEAPON

by Cody Cassidy
At 7:30 on a Tuesday morning in June, Room 2920 at the University of Arizona Cancer Center’s research complex in Tucson is one of the busiest places on campus. Doctors, pathologists, radiologists, nurses and social workers fill every seat at the expansive conference table, connected via video conference to team members 116 miles up Interstate 10 in downtown Phoenix. A gray-scale graphic overlaid by a data set is projected onto a large screen and is being scrutinized by the group. At a casual glance, those familiar with the world of cancer care will recognize this gathering as a standard tumor board meeting. A tumor board is a multidisciplinary group of experts who meet to discuss particular cases for which an oncologist needs guidance — for example, brainstorming treatment plans for a patient with difficult cancer.

Tumor boards are a staple in the world of oncology. The American College of Surgeons first established tumor boards in the 1920s in an effort to develop a multidisciplinary approach to comprehensive cancer care. They are divided into areas of expertise that focus on specific cancer types, such as lung, colon or breast. Oncologists present a case to the group and experts weigh in on best approaches to care and offer information on any clinical trials that may be available to that particular patient.

Something is fundamentally out of the ordinary about this particular tumor board meeting, however. A number of faces seem out of place, and the image projected onto the screen has different data than usual. One of these new faces is Michael Hammer, PhD. He is not a clinician, a radiologist or a pathologist. He is not a nurse or a social worker. In fact, he does not even have a background in oncology. But he is the one who is leading the discussion, and his rapt audience is hanging on his every word.

Dr. Hammer is an expert in human genetics and is the director of the UA Genetics Core, an on-campus group that helps UA researchers conduct specialized genomic analyses. He has a unique insight into the particular cancer case under review, and possesses information that until recently was not available to the rest of the group: information that will change the way tumor boards diagnose and treat cases like the one under review this morning. The information in Dr. Hammer’s
Michael Hammer, PhD, is director of the University of Arizona Genetics Core (UAGC) and a research scientist who has run a productive lab in human evolutionary genetics for the past 25 years. His lab has been an early adopter of next-generation sequencing technology, applying whole genome analysis in humans.
possession has to do with the genes that give rise to every tumor — genes that can be analyzed molecule by molecule, using equipment that isn’t a normal part of an oncologist’s lab. For this reason, this tumor board is formally referred to as the molecular oncology tumor board (MOTB). In contrast to a standard tumor board, an MOTB allows oncologists to take into consideration the number and types of mutations in tumor cells, treating the disease as one of genetics rather than focusing solely on a cancer’s location in the body.

**Molecular Oncology Tumor Board in Action**

Given the growing interest in the field of molecular oncology, the UA Cancer Center established its own MOTB in 2016. In its first year, the MOTB was presented with 23 cases, one of which was a 9-year-old boy. After experiencing night sweats, coughing, shortness of breath and weight loss, the patient was diagnosed at the UA Cancer Center with a rare and aggressive cancer known as gray zone lymphoma. Unfortunately, because it is so rare, no agreed-upon guidelines exist for how best to treat patients diagnosed with it.

The patient went through aggressive chemotherapy and radiation, but despite his physicians’ best efforts, his condition worsened.

*Continued on pg. 18*
“We were faced with a very challenging situation because the patient showed a very high resistance to conventional chemotherapy agents we had tried, and we had very few options given the limited therapies known in the literature,” says Yi Zeng, MD, PhD, the patient’s oncologist.

That’s when Dr. Zeng reached out to Dr. Hammer and his colleagues. Tumor sequencing revealed variants in the HDAC7, CIITA and STAT6 genes, and sequencing of the patient’s normal cells revealed inherited genes that may explain his unusual resistance to chemotherapy. This information allowed Dr. Zeng and the transplant physician, Emmanuel Katsanis, MD, to develop a personalized treatment plan that allowed the patient to achieve remission following bone marrow transplant.

**Precision-Guided Diagnosis**

Not all cancers are alike. In fact, even cancers that strike the same area of the body aren’t identical. In the past, our limited knowledge about cancer led to a generic, one-size-fits-all approach to treatment. So a treatment that was approved for use in patients with breast cancer may work well in some cases but not in others. And we often didn’t know why a treatment did or did not work, nor could we predict the success or failure of that treatment in a particular patient.

In 2001, the Human Genome Project was completed — a scientific breakthrough that unlocked the genetic code and gave us the ability to sequence our own DNA. This was a new technology that empowered humanity to discover specific genetic mutations that underlie a myriad of human conditions, including cancer.

Since then, with the advent of next-generation sequencing methods, creating genetic profiles of tumors has become routine, and cancers often can be further subdivided by mutation type. This is precision medicine in action, zeroing in on specific mutations to classify increasingly precise subtypes of cancer. Patients with tumors resistant to standard therapy, or who have a cancer so rare that treatment options are limited, might benefit from a tumor board with a focus on genomics that involves a broad array of experts in genetics, bioinformatics, bioethics and genetic counseling to discuss the implications of genetic sequencing results.

The MOTB at the UA Cancer Center was established as a pilot project in 2016, when it brought together multidisciplinary groups that do not often sit at the same table. Oncologists at the UA Cancer Center present cases to a core working group for consideration for analysis of a patient’s tumor cells and healthy cells.

**The Next Generation of Tumor Boards**

A typical MOTB meeting at the UA Cancer Center has two parts. First, an oncologist presents a case to the core group for consideration; second, for cases that previously had been submitted for sequencing, the board discusses the results, focusing on their scientific impact and whether the case
would fit into a case series for publication. Attendees debate the possible influence of specific mutations and whether a particular drug might work. Oncologists involved in clinical trials will weigh in on whether an experimental drug is the right match for the patient. Usually, two or three patient cases are discussed at each meeting.

Depending on how many genes are being sequenced, the cost of a molecular profile of a patient’s tumor can range from $1,000 to $3,000. About 1 percent of our genome is made up of genes that code for proteins; mutations in these genes can lead to diseases like cancer. A comprehensive 500-gene cancer panel covers a custom set of genes associated with cancer risk, treatment and prognosis. Another type of sequencing, called clinical exome sequencing, examines all protein-encoding genes, as well as other pertinent areas of the genome, to detect harmful mutations in a tumor — making it easier for oncologists to understand how to diagnose and treat a challenging case of cancer.

Finally, gene expression profiling looks at the sequence and abundance of RNA, the genetic information used by the body to make proteins. This type of sequencing can confirm the presence of genetic mutations, as well as genes or pieces of RNA that have been fused together to create abnormal proteins.
“Our MOTB provides a nuanced level of detail not found in sequencing reports from a commercial company or a hospital lab,” Dr. Hammer says. “Because we are a research lab, we can take a deeper look and sequence all of the genes in the tumor as well as those in the normal cells, which can help us to distinguish variants that are new to the tumor from those that were inherited and shared with other family members.”

Genomic sequencing is a new technology and is not part of the standard of care for cancer patients — and is therefore not always covered by insurance plans. The high return on investment, however, can make the hefty price tag worth it. The information provided to doctors and researchers decreases reliance on arbitrarily chosen treatments for patients and helps oncologists make decisions guided by scientific research. It also provides patients with a direct connection to phase I trials and drug development programs that may offer access to cutting-edge experimental treatments.

For researchers, sequencing capabilities and the MOTB facilitate translational bench-to-bedside research — the process of applying scientific discoveries to a patient’s care. And for patients and their families, the MOTB means they’re working with a team whose members have skill sets that reach far beyond the standard of care and into the raw genetic code of the human blueprint.

**Future Directions: Where We Go from Here**

Each new case brought to the MOTB adds to a growing data set of known gene variants linked to specific tumor types. While molecular technology continues to move forward at a fast pace and our database of tumor variants is growing, pharmaceutical companies and the UA Cancer Center’s own drug developers are also on an urgent mission to come up with new drugs.

But there are still many gene variants waiting to be identified. Detecting newly discovered variants in our own patients is at the core of the mission of the UA Cancer Center’s MOTB.

“We believe that an enhanced focus on the MOTB will aid in the development of a multi-pronged effort to enlarge our capacity for discovery at the UA Cancer Center in the area of precision medicine efforts,” says Dr. Hammer. “Given the plethora of cases of common resected diseases that have been sequenced, it is very important to prioritize the operational features of our MOTB.”

Dr. Hammer is working with researchers throughout the UA Cancer Center to prioritize a growing list of questions that could be addressed in future MOTB casework. For example, the MOTB may choose to sequence rare tumors as a case series or from patients with multiple cancer types, or to learn about tumor evolution by taking samples from the same patient at different time points to track changes in the tumor’s genes. Another approach would be to compare the genomic profiles of people with the same type of cancer but with very different outcomes, or to monitor a tumor’s genomic response to treatments.

As Dr. Hammer so aptly says, “To make the most of the research, we have to ask the right questions and sequence the right people.”

Understanding they cannot perform all tests on all patients, Dr. Hammer says the MOTB should focus on full genetic analysis of tumors. Working up a full genetic profile of a patient’s tumor will “provide research-level information for scientific discovery and, at the same time, has the potential to help oncologists to direct patients toward specific clinical trials.”

Long-term goals also include building a rare tumor registry, establishing new research directions, developing a complete database of gene variants and outcomes, and focusing on immunotherapy.

To be fair, genetic sequencing and other precision-medicine approaches are by no means a “silver bullet.” Many discoveries remain to be made, and a number of criticisms and cautionary tales must be taken into account. This is still a very new technology, however, and with every case the molecular oncology tumor board at the UA Cancer Center is giving each patient a new means to fight for their own health as well as the health of others.

*Supporting projects like the Molecular Oncology Tumor Board with a charitable gift sustains the UA Cancer Center’s broader mission of scientific discovery, which leads the way to the next clinical breakthroughs.*
AN EVOLUTIONARY BREAKTHROUGH FOR HUMAN MEDICINE AND RESEARCH

“The human genome holds an extraordinary trove of information about human development, physiology, medicine and evolution. Here we report the results of an international collaboration to produce and make freely available a draft sequence of the human genome. We also present an initial analysis of the data, describing some of the insights that can be gleaned from the sequence.”


Sixteen years ago, the scientific community introduced to the world something extraordinary. Emerging in the early 1980s as a global collaborative effort to decode the human genome, the Human Genome Project unlocked one of humankind’s most mysterious secrets. It is, in essence, the code for the operating system that drives us. By providing a complete sequence of the 3 billion DNA base pairs and roughly 25,000 genes that make up the human genome, we now had the entire blueprint for building a person.

What followed was a maelstrom of discovery as scientists moved to search for and unlock the root cause of myriad issues that have threatened the human condition for millennia. Prior to the Human Genome Project, scientists had knowledge of the genetic makeup of 60 disorders. By 2013, as a direct result of having this complete human blueprint, we were able to identify the basis of some 5,000 conditions, including autism, Crohn’s disease, Parkinson’s disease, hemophilia and many specific cancers. And as scientists are now able to use this information to develop novel drug therapies, they can begin to target specific conditions based on genomic sequencing. This discovery has ushered in the new phase in science and discovery that is precision medicine.
Humans have been practicing the healing arts at least since the days when papyrus scrolls contained the totality of our medical knowledge. Cancer was commonly thought to be caused by a bodily imbalance — an excess in black bile, if the ancient Greeks were to be believed, or an imbalance in qi, according to traditional Chinese medicine. While most ancient physicians considered cancer to be incurable, throughout history we have attempted to treat it with a range of interventions, from herbal medicines and oils, to arsenic and other harsh chemicals, to bloodletting and surgery. Unfortunately, for most of human history, cancer was a death sentence.

Today, both our understanding of cancer and our treatments for it have improved by leaps and bounds, feeding scientists’ optimism. That optimism has kept researchers busy, from the laboratory to patients’ bedsides. Initial investigation into new cancer treatments takes place far away from human subjects, with tests conducted in petri dishes and lab mice. But when one of these new agents shows promise in the laboratory, it’s time to test it in humans. These studies, called clinical trials, are the gold standard for figuring out which treatments are the most effective and the least harmful. The University of Arizona Cancer Center is Southern Arizona’s premier institution for clinical trials of new cancer drugs, and currently is conducting about 200 investigations into treatments for a variety of cancer types.

Clinical trials proceed in stages, starting in small sets of patients and expanding to larger groups as research objectives are met. Phase I clinical trials are the earliest investigations into a promising new drug. These “first-in-human” studies figure out if a treatment is safe and what dosage to administer. Subjects usually start out at low doses of the experimental drug; this dosage is slowly increased so researchers can see when side effects start to emerge. With a lot of work and a little bit of luck, they will find a drug that can be given at a dose high enough to show promise, but low enough not to cause intolerable side effects. These trials might also give early hints of a drug’s potential to fight cancer.
Our Phase I Program: Bringing Cutting-Edge Treatments to Arizona

Since its inception, the UA Cancer Center has participated in phase I trials, but these offerings were formalized when former UA Cancer Center director Daniel Von Hoff, MD, created a structured Phase I Program. Under Dr. Von Hoff’s mentorship, Daruka Mahadevan, MD, PhD, took over as director from 2007 through 2012. After a stint in Memphis, where he was director of the phase I program at the University of Tennessee’s West Clinic, Dr. Mahadevan was recruited back to the UA Cancer Center in January 2016 to direct the Phase I Program here. Since then, the program has steadily expanded.

Ruth Cañamar, the Phase I Program manager, speaks to this growth: “In a year and a half since the arrival of Dr. Mahadevan, we opened enrollment to 12 trials, doubled the size of our team and have enrolled 35 patients.”

The UA Cancer Center can’t do clinical trials without committed researchers and committed patients who participate in trials to help us understand new drugs. Researchers benefit from clinical trials when they learn more about how a new drug works in an actual living human — rather than in a test tube or lab animal. Patients benefit by gaining access to innovative investigational treatments, the costs of which generally are covered by pharmaceutical companies and a patient’s health insurance provider. Further down the line, future patients benefit when these trials culminate in the approval of safer, more effective cancer therapies, especially for cancers for which no other treatment options exist.

The swift advances made by basic science in recent years have driven the strides made in cancer treatment. Researchers in fields as diverse as translational medicine, cancer biology and imaging have built such a strong foundation for phase I trials that some of these new drugs have received accelerated FDA approval after showing positive results in those trials.

“The rule of thumb from a long time ago was 1 in 15 trials would pan out in phase I,” says Hani Babiker, MD, associate director of the Phase I Program. “Now we’re seeing more than 30 percent over the last two years or three years. It’s a really exciting field.”

With the increasing success of phase I trials in recent years, they are quickly shaking their reputation as a last resort in a cancer patient’s journey through available treatments.

“Phase I [studies] aren’t the same as they were just a few years ago,” says Ms. Cañamar, speaking to the taboo that, until recently, clung to phase I trials. “They’re clinical trials with real benefit to a patient. The reputation has changed, so they’re not the scary phase of a trial to get treatment on.”

Building Bridges

The UA Cancer Center’s involvement with phase I trials helps us build relationships with pharmaceutical companies, both big and small. For example, the UA Cancer Center has been designated as a preferred site by Bristol-Myers Squibb, which means we can work with the pharmaceutical giant from preclinical studies all the way through clinical trials.

“We are first in line to get their trials. They trust that we’re going to run the trial well,” Ms. Cañamar tells us, adding that our preferred site status also opens doors for UA Cancer Center scientists doing preclinical research. “Basic scientists don’t normally have that opportunity to work with big pharma, because usually these companies already have their own built-in labs, but they do want to work with academic health centers.”

The Phase I Program doesn’t just allow the UA Cancer Center to build relationships with big players in the pharmaceutical industry; it also allows us to make inroads into the community. Drs. Babiker and Mahadevan regularly meet with Tucson oncologists to make them aware of phase I studies available at the UA Cancer Center, increasing the referrals we get from the community. Often, there can be tension between the UA Cancer Center and other community oncologists, who fear we might be trying to retain their patients, but they are put at ease when they learn they will be kept apprised of their patients’ progress on a trial, and that their patients will return to them for care once a trial is over.
“We really are building a bridge with the community,” says Ms. Cañamar. “We have great trials and drugs that you can’t get in the community.”

**Better Care, More Hope**

Phase I studies also can offer an additional layer of care to an embattled cancer patient who has already been through standard therapies, but whose cancer continues to progress. These patients may be deeply fatigued by the often physically taxing, emotionally draining experience of cancer treatment, and might suffer from malnutrition, depression, compromised immune systems and organs on the verge of malfunction. UA Cancer Center researchers make sure these patients have access to nutritionists, physical therapists and social workers, all of whom can help them be at their best, giving them an edge as their bodies respond to experimental treatments.

All participants in phase I trials receive full genetic testing of their tumors, with specimens being sent to a central repository, or “biobank,” where they will help future scientists expand their understanding of cancer. Furthermore, receiving
A full genetic profile of their cancer allows patients to be matched to a study targeted to their tumor type — a helpful opportunity for a patient, especially as our concept of cancer transitions from being a disease of an organ system to a disease of genetic mutations and aberrations.

Participation in these trials also can offer a source of hope to patients who have exhausted standard treatment options. Dr. Babiker mentions a patient whose cancer continued to grow even after he had completed two chemotherapy regimens. The toll the drugs had taken on his body was too high, and, with no more fight left, he resigned himself to spending his last days in hospice. A new drug, however, provided fresh optimism, and the patient decided to give treatment one last shot — and he responded to the experimental drug, experiencing a 73-percent reduction in his tumor.

“Right now, he’s active and he’s out of hospice,” reports Dr. Babiker, adding that being able to give hope to patients who thought they had run out of options is the most rewarding aspect of his work, especially when these treatments not only extend patients’ survival, but also enhance their quality of life.
“It’s like a snowball,” Dr. Babiker says. “You know if you help that patient, a lot of other patients are going to get better. That tops it all!”

**Immunotherapy: The Fourth Modality**

Unfortunately, despite the success stories, on the whole, cancer treatments are notorious for causing terrible side effects — you’ve probably heard patients lament that “the cure is worse than the disease.” While standard cancer treatments like chemotherapy and radiation attack cancer cells, they also can harm normal cells, which can make for an often punishing treatment regimen. Cancer doctors and their patients dream of a “magic bullet” — a drug that takes out tumors with sniper-like precision, leaving healthy cells alone.

Many experimental treatments fall outside the scope of surgery, radiation and chemotherapy. For example, immunotherapy is an emerging type of cancer treatment that can train the immune system to recognize and attack cancer cells. In fact, it was an experimental immunotherapy drug that gave Dr. Babiker’s formerly hospice-bound patient a new lease on life.

Julie Bauman, MD, MPH, the division chief of hematology and oncology at the UA College of Medicine – Tucson Department of Medicine, calls immunotherapy “the fourth modality,” after surgery, radiation and chemotherapy. While chemotherapeutic drugs have direct toxic effects on cancer cells, “immunotherapy doesn’t touch the cancer cell, per se,” Dr. Bauman explains. “Instead, it reactivates immune cells in your system to fight the cancer. When it works, the patient has a living army battling the cancer every day.”

UA Cancer Center is participating in the phase I trial for one such immunotherapy drug candidate. Promising preliminary results were reported at June’s American Society of Clinical Oncology meeting, showing that the drug was effective against locally advanced and metastatic cutaneous squamous cell carcinoma, a type of cancer that doesn’t have a standard treatment option. Overall, 12 of 23 patients — 52 percent — saw their tumors shrink, including two patients whose locally advanced cancers went into complete remission. As the study continues, researchers will learn more about this drug’s safety and effectiveness, but these positive early results are not lost on researchers.

“An overall response rate of more than 50 percent in a rare tumor that’s stage IV, that we don’t have any other options to treat with, is really huge,” says Dr. Babiker, who is leading this trial at UA Cancer Center.

“The most exciting trials I’ve done are those where we bring novel immunotherapies to patients with advanced head and neck cancer,” Dr. Bauman says. She has contributed to clinical trials that paved the way for the recent FDA approval of pembrolizumab (Keytruda®) and nivolumab (Opdivo®), two immunotherapies that are showing great promise in certain patient populations. Pembrolizumab gained some prominence when it was revealed to be the drug that helped put former President Jimmy Carter’s melanoma in remission — some media sources even referred to it as the “Jimmy Carter drug.”

For all of its promise, immunotherapy poses challenges. While it has a reputation for being less toxic than chemotherapy, it still carries the risk of autoimmune side effects — reactions that can happen when the immune system becomes too vigilant, attacking healthy cells in addition to cancer cells.

“Sometimes we ‘over-rev’ the immune system and we get autoimmune side effects,” Dr. Bauman says. “Those can be just as dangerous as immune-suppressive chemotherapy. We have to learn how to use immunotherapy, but we also have to learn how to make it more specific to cancer, so the immune system is educated to fight the cancer but not the patient.”

Not all cancers are susceptible to immunotherapy drugs — but researchers are hard at work finding drugs that will break down tumor cells’ defenses, making them more vulnerable to attack from the immune system and clearing the way for immunotherapy to do its job.
“Some tumor types are immunologically ‘cold,’” Dr. Mahadevan tells us, referring to cancers that fail to respond to immunotherapy. “In order to make them ‘hot,’ investigations are ongoing with novel combinations.” These drug combinations can deliver an efficient one-two punch to tumors that formerly were resistant to immunotherapy.

For example, oncolytic viruses, which are genetically engineered to target cancer cells, are under investigation at the UA Cancer Center. Dr. Mahadevan is overseeing research into the combination of an oncolytic virus with an immunotherapy drug. The lab-created virus infects tumors while ignoring healthy cells. Before succumbing to the lethal effects of the virus, the cancer cell is hijacked to produce more anti-cancer viruses, which go on to infect more tumor cells — a viral infection that actually works to the patient’s advantage.

Tumor cells killed by this virus also send signals to the immune system, triggering it to mount a targeted defense. This viral attack sets the stage for the immunotherapy drug, which attaches to the surfaces of immune cells and mounts a robust immune response. Researchers hope these two treatments, in tandem, can shrink tumors even more efficiently than they could by themselves.

**Phase I Trials Give UA Cancer Center an Edge**

These types of trials make the UA Cancer Center competitive, not only in Tucson, but nationwide. The study investigating the oncolytic virus, for example, is only open in a handful of cancer centers in the United States — not just here at the UA Cancer Center, but also at locations in California, Indiana and Michigan, giving us the ability to draw patients from across the region.

Another factor in keeping the UA Cancer Center competitive with other cancer centers is our ability to keep up with the fast pace at which phase I trials are conducted. The UA Cancer Center needs to be able to open trials quickly, which requires a small army of people across multiple departments working behind the scenes to put together paperwork for the U.S. Food and Drug Administration, institutional review boards and patients, and to negotiate budgets and contracts between the university and pharmaceutical companies. And, thanks to certification from the Western Institutional Review Board, the UA Cancer Center receives expedited reviews of most industry trials, which gives us an edge.

“It’s a selling point for us,” says Ms. Cañamar. “We can really push to open our trials quickly. As an academic institution, we’re pretty competitive and are often complimented by sponsors at how quickly we have opened and completed their trials.”

The Phase I Program is an invaluable resource to cancer patients, who are able to become among the first to receive pioneering treatments that would not be available anywhere else.

“The goal of our Phase I Program is to provide an outstanding and compassionate service to our cancer patients with cutting-edge investigational agents,” Dr. Mahadevan says. “We are here to care for every single cancer patient who needs our help.”

From the herbal remedies and bloodletting of yesterday, to the immunotherapy and cancer-killing viruses of tomorrow, medical knowledge has expanded in ways our ancestors never could have dreamed of. If research continues apace, perhaps the next generation of patients will be benefiting from treatments that we are only beginning to imagine. To transform those dreams into reality, we need our Phase I Program to be as robust as possible, so it can contribute to the rapid accumulation of scientific knowledge — and deliver the medicine of the future to our patients today.
“As an alum, you always have a bloodline. I just have a different bloodline to the UA — through the Cancer Center.”
Looking Forward by Giving Back

by Kenya Johnson

Brad Marsh describes his mother, Ellen Berg, as a woman who was hard working, well-read and truly ahead of her time. She was an avid reader of Prevention Magazine.

Her children were the epicenter of her life. And although she grew up in Nebraska, Ellen loved Tucson, where she moved with her husband and kids in 1970.

According to her son, she wouldn’t have lived anywhere else.

In 1986, Ellen was diagnosed with kidney cancer. The kidney was successfully removed, but the cancer ended up coming back fairly aggressively. That’s when the family sought treatment at the University of Arizona Cancer Center. The UA Cancer Center’s founding director, Sydney E. Salmon, MD, led the charge in Ellen’s treatment plan, enrolling her in a clinical trial.
"When we got her in at the Cancer Center, there was a battery of physicians there, and Dr. Salmon was the key driver," Brad recalls. "She was in a clinical trial because the cancer had moved to her lung. Eventually, it became engulfed around her spine."

Sadly, Ellen Berg passed away in November 1986. However, because of his mother’s experience as a cancer patient, Brad and his wife, Sarah, were inspired to do more to fight cancer. "Our vision is to be more predictive than reactive so that people don’t have to go through what we did."

Although they call Chicago home, Brad and Sarah have maintained solid connections to the Tucson community and the university through friends, family and philanthropy.

For more than 30 years, they have supported the UA Cancer Center. Working with the UA Foundation, they recently established the Bradley and Sarah Marsh Endowment for Cancer Research.

"We’ve been contributing since my mother passed away," Brad says. "It was a natural step for us to set up an endowment because we don’t have any direct heirs. We knew this was a better use of our resources down the road.

“What I’ve always liked is that we’ve just quietly been giving all of these years, and it was nice to have people from the UA connect with us. They send us literature to let us know how things are progressing in cancer research. It’s nice to get the cards that we receive; it makes you part of the family."

Brad was diagnosed with melanoma in 1999, but it was caught early and treated in Chicago. Finding cures for cancer are at the top of his wish list, and he would like to see the UA Cancer Center discover and develop a predictive tool to prevent the disease altogether.

“We didn’t have the foresight to get to the UA sooner with my mother,” Brad says. “Knowing what I know today, we wouldn’t be in that predicament.

“My mother’s experience made us more aware of what we need to know. We interview our doctors first because it’s important for us to understand ‘where they are’ fundamentally. We’ve educated our doctors on some of the more nontraditional things we do to maintain our health. In the long run, her sacrifice benefitted us.”

Through their endowment, Brad and Sarah Marsh want to make sure that progress in cancer research and discovery continues, especially in a time when government funding isn’t always around.

“It would be really nice if more people donated who didn’t have to go through the experience," Brad says. "A few dollars over time is meaningful, and I would rather have my money go to a meaningful place. We don’t donate anywhere else. Just the UA.”
The UA Cancer Center’s founding director, Sydney E. Salmon, MD, was the “key driver” in Ellen Berg’s care when she received treatment here.

For more information on supporting the UA Cancer Center with a gift from your estate, please contact the UA Cancer Center Development Office at give@uahs.arizona.edu or 520-626-5752 or 877-518-4638.
At the University of Arizona, we are taking bold approaches to our greatest challenges. At the Cancer Center, our scientists, physicians, researchers, nurses and staff are committed to one thing — to prevent and cure cancer.

For more information on how you can make a difference and support cancer research, please contact the UA Cancer Center Development Office at 520-626-5752, toll-free at 877-518-4638, or give@uahs.arizona.edu

The Phase I Program at the UA Cancer Center provides cutting-edge care to patients whose cancer has progressed on standard chemotherapy. Patients in phase I clinical trials receive full genetic profiling of their tumors, in addition to comprehensive and unique care focused on cancer treatment, nutrition, optimal physical activity, and mental health wellbeing through diverse specialists and support groups.
BEARDOWN BEAT CANCER

UACC is the only cancer center headquartered in Arizona, and currently is one of only 49 in the nation, to earn the National Cancer Institute’s Comprehensive Cancer Center designation, which demonstrates our scientific leadership, the breadth and depth of our research, and the spirit of collaboration we nurture among scientists. As a leader in the national dialogue on cancer, UACC is initiating rapid advances in research and patients’ health.

- We’re training the next generation of scientists and physicians to take on cancer.
- We’re leading initiatives that reduce cancer health disparities in underserved populations in our state.
- We’re inspired by our patients, every day, to build a better future.