

SHINING A LIGHT
ON MUCOSITIS

'CURED' IS
ONLY THE BEGINNING

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NEW HOPE

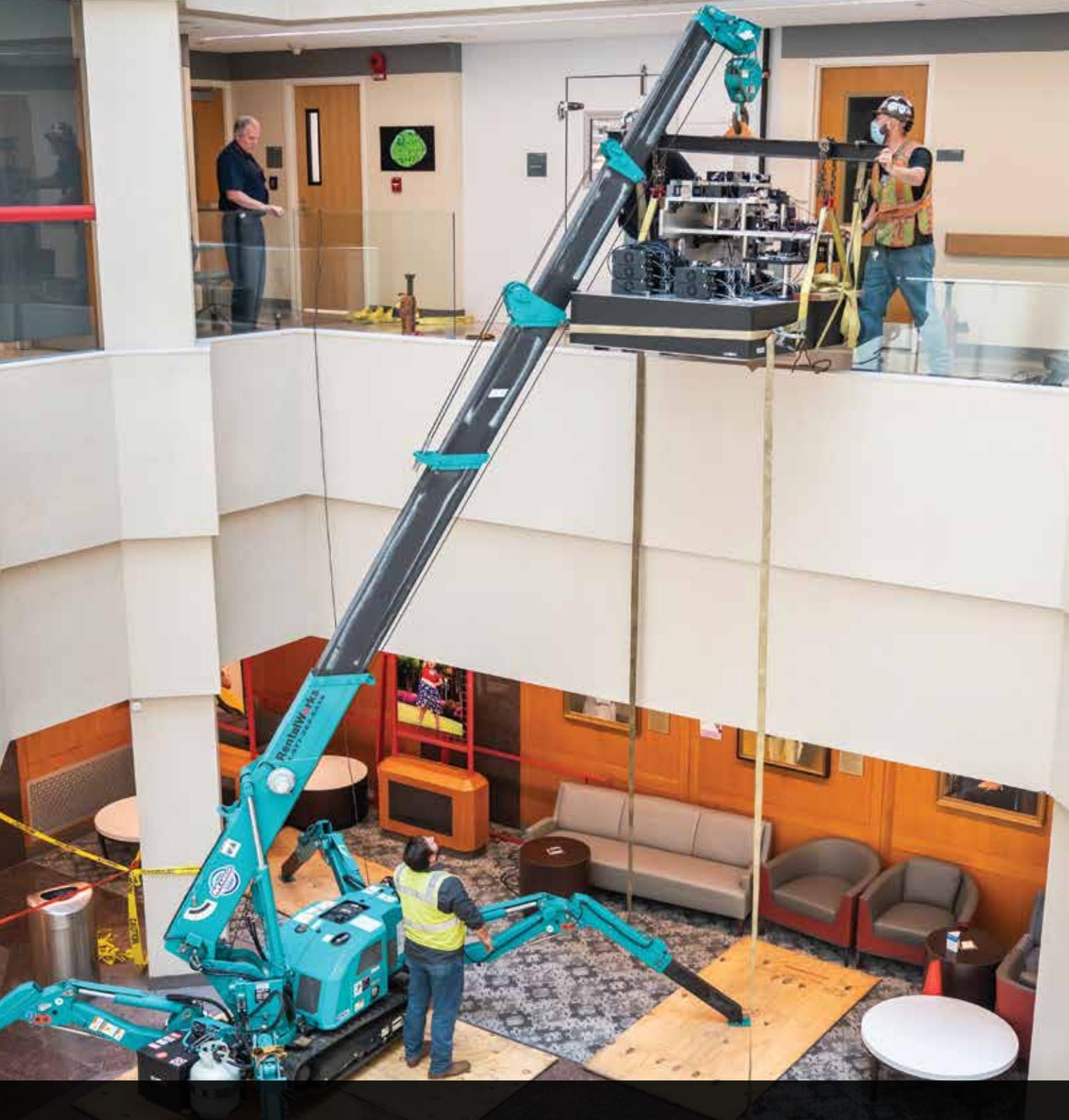
FOR
CHILDREN
WITH
SEVERE
SICKLE CELL
DISEASE

featuring

THE
VON HIPPEL-LINDAU
CLINICAL CARE
CENTER

THE ST. JUDE STRATEGIC PLAN

ACCELERATING
PROGRESS
GLOBALLY



Mosaic moves

As investigators began to move their labs to the new Advanced Research Center this summer, some equipment – such as the 1,400 lb. Mosaic microscope – required special handling. This delicate and highly sophisticated tool allows scientists to image deeper into tissues than has been possible before. A next-generation adaptive optics microscope, it is one of only a handful in development. Situated in its new home in the Advanced Research Center, it will help scientists answer biological questions that other systems cannot address.

Cover Story

06 // Something to Dance About

A new clinical trial for sickle cell disease

Features

03 // Accelerating Progress Globally

The 2022-27 St. Jude Strategic Plan

10 // Focusing on an Invisible Foe

The von Hippel-Lindau Clinical Care Center

14 // Prospectors Share the Wealth

Sharing findings, tools with the world

18 // Shining a Light on Mucositis

A painless therapy for a side effect of bone marrow transplantation

21 // A Global View of ALL

Offering hope in countries near and far

News and Highlights

25 // News from the Hospital

Life after St. Jude

28 // 'Cured' Is Only the Beginning

St. Jude survivor Katie Chinn Weyer



JUSTIN VENEMAN

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ON THE COVER: Photo of Anaiya Buchanan by Seth Dixon

The mission of St. Jude Children's Research Hospital is to advance cures, and means of prevention, for pediatric catastrophic diseases through research and treatment.

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By Elizabeth Jane Walker



JAMES R. DOWNING, MD

Accelerating Progress Globally

At its heart, the 2022–27 St. Jude Strategic Plan is a call to accelerate progress on a worldwide scale.

GAZE UPWARD in the atrium of the Advanced Research Center at St. Jude Children's Research Hospital to behold the vast possibilities of science. This building, with its gleaming laboratories, is a testament to the spirit of discovery, a massive space to explore and push bound-

daries. As scientists move their labs into the imposing structure this summer, the excitement is palpable. Not only does the moment mark a new beginning for the research community, but it occurs at the start of an \$11.5 billion strategic plan that offers world-changing potential.

"It is an exciting time for St. Jude," says James R. Downing, MD, the hospital's president and chief executive officer.

Under Downing's guidance, the institution recently completed its largest expansion in history. Among other feats, the hospital increased the number of patients in its clinical trials, recruited outstanding faculty and staff, reimagined its international outreach efforts, enhanced laboratory research, invested in technology and expanded the campus.

Incredibly, St. Jude stands poised to do more.

THE CHALLENGE BEFORE US

In spite of survival gains, 1 in 5 children with cancer in the U.S. still die of their disease. Certain pediatric cancers



remain incurable. For others, success has plateaued. Globally, the outlook is much worse, with 8 of 10 childhood cancer patients dying. Cures also remain elusive for those with neurologic disorders and some nonmalignant blood diseases.

A few years ago, Downing enlisted more than 200 employees to ponder these challenges. He posed two provocative questions: "How can we uniquely accelerate progress for children in Memphis and around the globe?" and "If not St. Jude, then who?"

The 2022–27 St. Jude Strategic Plan answers both questions.

The plan outlines areas where St. Jude can contribute toward progress: fundamental science, childhood cancer and other life-threatening diseases, global impact, and workforce and environment.

"We can make a major difference in the world by focusing our resources, our



energy, our intellect, on these problems,” Downing says.

FOCUS ON FUNDAMENTAL SCIENCE

Medical advances are born in the minds and hearts of scientists who use a basic understanding of biology to make discoveries and generate new knowledge. That’s why St. Jude will invest about \$1 billion in fundamental science during the next six years.

Building on momentum from the last strategic plan, the institution will increase the number of faculty in basic research departments by 33%; develop new shared resources, technology centers and centers of excellence; and enhance data sciences. The St. Jude Graduate School of Biomedical Sciences will also increase enrollment and add degree programs.

FOCUS ON CHILDHOOD CANCER

For nearly 60 years, St. Jude faculty and staff have worked to advance cures for children with cancer. During the next six years, the hospital will expand clinical care and research by developing new approaches

ANN-MARGARET HEDGES



to curing the incurable, to reducing the long-term side effects of treatment, and to creating a world where every child benefits from our discoveries.

“Cancer is remarkably complex,” says Charles Roberts, MD, PhD, executive vice president and director of the Comprehensive Cancer Center. “We need dedicated research to understand exactly what is going on in cells and what goes wrong when they

develop cancer. It’s only with that level of insight that we are likely to be able to cure all children with cancer.”

St. Jude scientists want to identify the most promising therapies — whether developed at St. Jude or elsewhere — and move them rapidly and safely from the laboratory to the bedside. Researchers will explore new ways to harness the power of the immune system to treat solid tumors and brain tumors. Providers will also enhance the care delivered at the hospital’s affiliates and expand clinical trials so that St. Jude can reach more patients across the nation and the world. Through those efforts, researchers will work to reduce the lasting side effects of cancer treatment, thus ensuring a better life for all survivors.

FOCUS ON CHILDHOOD CATASTROPHIC DISEASES

Although pediatric cancer has been a major focus of St. Jude since its inception, the hospital has also developed transformative programs in other life-threatening disorders. These include sickle cell disease, hemophilia, HIV/AIDS and other infectious diseases. Now, St. Jude will expand its research and



treatment programs to advance cures for life-threatening diseases of childhood.

The \$1.1 billion investment includes work in nonmalignant hematological diseases, such as sickle cell disease; a new laboratory-based research program in childhood infectious diseases; and a new research and clinical program to better understand and treat pediatric neurological diseases.

FOCUS ON GLOBAL IMPACT

To address the health care disparity of children who live in limited-resource countries, St. Jude will more than triple its investment in international efforts coordinated through St. Jude Global and the St. Jude Global Alliance.

“The No. 1 predictor of who will survive cancer is where that child lives,” says Carlos Rodriguez-Galindo, MD, executive vice president and director of St. Jude Global. “We are committed to making sure that every child everywhere has access to quality care and that every child has the chance to be cured.”

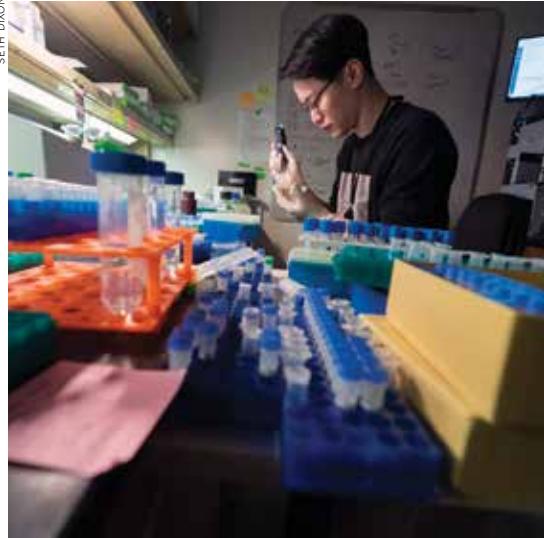
The new strategic plan calls for expanding educational programs so that health care workers worldwide can obtain the training they need to treat children with cancer. St. Jude will work to strengthen the systems needed to deliver that care, as well as crucial research infrastructure. The hospital will also create seven inter-



national operational hubs across alliance sites, which span more than 140 institutions across 50-plus countries.

In collaboration with World Health Organization, other U.N. agencies and international organizations, St. Jude will develop a Pediatric Cancer Global Drug Access Program. This program will distribute an uninterrupted supply of anti-cancer drugs for childhood cancer treatment in low- and middle-income countries.

“By 2027, we will have started a global movement to reach out to every single child with cancer,” Galindo says. “It will be unstoppable.”



FOCUS ON WORKFORCE AND ENVIRONMENT

The strategic plan will ensure that St. Jude remains a place where teamwork flourishes; internal and external collaboration thrives; and employees can make a difference in children’s lives. The plan calls for more than doubling the St. Jude Research Collaboratives program, in which experts from different institutions unite to answer complex scientific questions. The hospital’s blue-sky process, which solicits mission-related, game-changing ideas outside of the strategic plan, will also expand, allowing St. Jude to pursue more projects that could transform science and medicine.

In addition, several construction projects will allow employees to do their best work, and enrich the lives of patients and their families.

FOCUS ON THE MISSION—ALL DAY, EVERY DAY

As Downing contemplates the broad scope of the 2022–27 strategic plan, he acknowledges that it is ambitious, even audacious, but grounded in an inspiring and enduring mission.

“This plan is bold,” Downing says. “We’re tackling the hardest problems, and we’re not going to shy away from them.”

“It is driven by a dream,” he adds, “the dream of our founder, Danny Thomas—that no child should die in the dawn of life.”

Some photos for this article were taken pre-COVID-19.

Something to Dance About

A St. Jude clinical trial tests a gentler approach to stem cell transplantation for children with severe sickle cell disease.

SHE'S USUALLY PRETTY SHY, but when someone mentions dance videos, 12-year-old Anaiya Buchanan lights up. She adores busting a move to music and has posted over 340 videos on TikTok, the social media platform that's all the rage with tweens.

Anaiya's feisty side has helped her withstand years of painful and life-threatening complications from severe sickle cell disease.

The diagnosis came when she was just 1 week old. Monthly blood transfusions over the years lessened her symptoms and reduced her risk of stroke but led to a buildup of iron in her organs, putting her at risk for liver and heart damage.

Anaiya is one of the first patients to take part in the Sickle Cell Disease Hematopoietic Cell Transplantation (SCDHCT) study at St. Jude Children's Research Hospital. This clinical trial aims to cure children with severe sickle cell disease. Researchers hope to achieve high success rates with a transplantation approach that uses a gentler chemotherapy and radiation conditioning regimen than standard transplants. The goal is to maximize the odds for a cure while reducing side effects and subsequent health issues.

IMPROVING OUTCOMES

Sickle cell disease is the most common inherited blood disorder in the U.S., affecting an estimated 100,000 people. About 1 in 365 Black babies in the U.S. is born with the condition. Decades ago, half of all children with the disease did not live past age 20, and most did not survive to 50. Today, with

early diagnosis and innovative treatments, most live to 50 or beyond.

Sickle cell disease causes normally round or donut-shaped red blood cells to take on a crescent or sickle shape. This hampers their ability to move through the body and deliver oxygen to tissues. When sickled cells block blood flow to joints, organs or bones, the result is a pain episode or crisis. If blood supply to the brain is compromised, it could result in a stroke. People with sickle cell disease are also at a higher risk of developing infections because many have their spleen removed or damaged early in life.

From her earliest days, Anaiya often experienced pain crises and pneumonia. She had a life-threatening concentration of sickle cell blood in her spleen and required hospitalization when she was 9 months old. By the time she was 2, St. Jude doctors discovered the velocity of blood flow to her brain was elevated, meaning she



Gotta dance

How does an aspiring video star generate social media posts while undergoing a bone marrow transplant? By enlisting the help of her care team, of course. Joining Anaiya in the fun are (from left) Rebecca Elrod, RN; Katelyn Park, RN; Christin Mays, RN; and Jackie Hopson, PCA.

was at high risk of having a stroke. Anaiya visited St. Jude every six weeks for blood transfusions to replace her sickled blood with normal blood from donors to reduce her pain episodes and the risk of stroke.

Stem cell transplantation, also known as bone marrow transplantation, is the only known cure for sickle cell disease, with about 95% of children treated achieving long-term cure. However, transplantation requires a suitably matched donor and carries risks of long-term complications. Until recently, most transplants used a high dose of



By Jane Langille



chemotherapy drugs, also called a conditioning regimen, to prepare patients to accept donor stem cells and prevent rejection.

"Typical pre-transplant conditioning can cause a lot of organ injury and longer-term problems, even for patients who tolerate the transplant procedure well," says Akshay Sharma, MBBS, who leads the study.

LEGACY OF FIRSTS

St. Jude has been researching sickle cell disease since before the hospital opened in 1962. One of the institution's earliest clinicians, Lemuel Diggs, MD, received the institution's first grant, which was earmarked to study the disorder. A St. Jude patient was also the first in the world to be cured of sickle cell disease with a bone marrow transplant. When the 8-year-old girl underwent a transplant for acute myeloid leukemia in 1983, she was also cured of her sickle cell disease.

Since then, most clinicians have used high-intensity chemotherapy before sickle cell disease transplants, just like transplants done to treat patients with leukemia. By the early 2000s, however, investigators started exploring less-intense regimens, testing chemotherapy doses that were 70 to 90% of standard doses.

About six years ago, sickle cell disease researchers at the National Institutes of Health (NIH) discovered that no up-front chemotherapy-based conditioning was

required to cure some individuals with sickle cell disease who received fully matched transplants from their siblings.

"That made transplant much more appealing to patients, but it had a problem: As conditioning intensity decreases, the risk of graft rejection increases," Sharma says. "So, we increased the conditioning intensity by adding just a little bit of chemotherapy to prevent rejection."

The SCDHCT clinical trial aims to enroll 40 patients under age 25 who have severe sickle cell disease — 20 individuals with fully matched sibling donors and 20 with half-matched, or haploidentical, donors.

Not every patient has a brother or sister who is a perfect match, so the ability to use a parent (a half-matched donor) is an exciting option. The SCDHCT clinical trial is also appealing to many patients because it offers a gentler treatment regimen than has been used in the past.

"Patients in our study receive reduced-intensity conditioning, than what is used in standard transplants," Sharma explains. "We hope this approach will successfully cure sickle cell disease with much less short- and long-term toxicity."

EXCEPTIONAL CARE

St. Jude has a long-standing commitment to improving the lives of children with sickle cell disease. The nurse-to-patient ratio of 1:3 for treatments to manage symptoms and 1:1

Giving back

Now that her transplant is done, Anaiya wants to help other children who are considering transplants. "She spoke with another of one our young patients who was coming for transplant on this protocol," says Nurse practitioner Amanda Kennedy (at left). "Anaiya gave her a heads up, sharing what she had been through and what to expect."

for patients in the ICU after transplant is unmatched by most other hospitals.

Physician Assistant Darla Pickett oversees chronic blood transfusions for St. Jude patients with sickle cell disease. She provided care to Anaiya for five years leading up to the transplant.

"Medication helped to lower Anaiya's iron levels but then caused some kidney issues," Pickett says. "Chronic transfusions were helpful to alleviate her symptoms, but they were never going to be a cure."

Sonja Carruthers, Anaiya's grandmother and guardian, heard about SCDHCT during a talk on sickle cell disease at the hospital.

"I signed her up for the study right away," Carruthers says. "Transplant was her best chance to be cured and to leave behind transfusions and their side effects."

CAREFUL CHOREOGRAPHY

Like Anaiya's dance moves, transplantation involves carefully executed, well-timed steps that begin a couple of months in advance. First, the patient receives a two-drug preconditioning treatment by mouth to reduce the risk of rejecting the donor stem cells, known as a graft.

Next, the individual receives reduced-intensity chemotherapy and low-dose total body radiation. This prepares the patient to receive the donor's stem cells on transplant day.

After the transplant, the patient receives medications to help prevent graft-versus-host disease and graft rejection.

Anaiya received a haploidentical transplant from her mom in August of 2020. She was the first person in the clinical trial to receive a half-matched transplant, and her treatment team says she has re-



AKSHAY SHARMA, MBBS

"It's very fulfilling as a physician and researcher to see that our trial is helping kids get back to being kids again. They are my inspiration."

—Akshay Sharma, MBBS

sponded well to the treatment.

Nurse practitioner Amanda Kennedy met Anaiya a couple of months before her

transplant and will continue to care for her during the next several years. The bond they have developed is strong.

"Anaiya didn't want to talk with me at first. She's very picky about who she lets in," Kennedy says. "But once she does, that girl's got attitude. She's a little stubborn and sassy, in all the right ways."

"Anaiya's a fighter," Kennedy continues. "She lost her hair, had nausea, pain and other issues, but she bounced back quickly, and now she wants to give back. She spoke with another of one our young patients who was coming for transplant on this protocol. Anaiya gave her a heads up, sharing what she had been through and what to expect."

DANCE LIKE EVERYONE'S WATCHING

During her time at St. Jude, Anaiya convinced members of the nursing staff to make fun dance videos with her, and now she aspires to be a St. Jude nurse.

Her more immediate wish list includes a rollerblading party, getting involved in basketball and track, and of course, shooting more videos with her phone and adding special effects.

"Since receiving her transplant, Anaiya hasn't had any pain crises and has lots more energy," Carruthers observes.

Sharma says he hopes to see similar positive responses from other patients in the clinical trial.

"It's remarkable how the transplant process has completely changed Anaiya's life," he says, "Earlier, she needed to come to the hospital every few weeks because of pain crises or for blood transfusions; now, she is out and about — doing her thing as a pre-teen and enjoying life."

"It's very fulfilling as a physician and researcher to see that our trial is helping kids get back to being kids again. They are my inspiration." ■



By **Mike O'Kelly**

Focusing on an Invisible Foe

As a von Hippel-Lindau Clinical Care Center, St. Jude can focus the treatment experience for families affected by the rare genetic disorder.

SHANA MAYFIELD AND HER FAMILY were enjoying lunch at a restaurant in their Missouri hometown in the summer of 2019 when her cell phone rang. The voice on the other end was Gina Nuccio, a genetic counselor at St. Jude Children's Research Hospital. Shana navigated a gamut of emotions during the conversation, which was simultaneously affirming, terrifying and encouraging. It was the first time she heard the words von Hippel-Lindau syndrome.

A few months earlier, Shana's 11-year-old son, Jacob, had undergone surgery at St. Jude to remove a tumor from his right adrenal gland. Lab results showed that he had the rare syndrome.

Affecting about 1 in 30,000 children and adults, von Hippel-Lindau (VHL) syndrome is caused by changes in a gene called *VHL*. Because the gene plays a role

in the life cycle of cells, it can lead to the development of tumors throughout the body. Tumors can be benign or cancerous and can lead to complications such as blindness, hearing loss or death.

Jacob's diagnosis meant the St. Jude Cancer Predisposition team would monitor him closely through annual scans and checkups.

Jacob felt much improved after surgery, competing in league basketball two weeks after the procedure. But there was still cause for concern. About 80% of people with von Hippel-Lindau syndrome inherit the gene mutation from a parent with the syndrome. Shana and her husband, Jody, never imagined they and their three children could be at risk.

FAMILY MATTERS

Nuccio sent four sample-collection kits to the Mayfields for *VHL* testing. She called again with the unsettling results: Shana

Support for the family

When Jacob Mayfield (center), tested positive for von Hippel-Lindau syndrome, St. Jude tested the entire family. His siblings, Sarah and Collin (pictured), also tested positive, as well as their mom. The St. Jude Cancer Predisposition team monitors all three children, who are at risk of developing tumors throughout their lives. Tumor surveillance can include imaging of the brain, spine and abdomen; lab work; and a general physical exam.



The Cancer Predisposition Family Conference on von Hippel-Lindau Syndrome

December 2–3, 2021

For information, email:
GPSFamilyConference
@STJUDE.ORG

and their two youngest children had also tested positive.

People with the *VHL* mutation have a 50% chance of passing it to their children, but those odds reset with each birth.

"We weren't anticipating that. If there are only about 10,000 cases in the U.S., you don't expect that many people in



KIM NICHOLS, MD

one house to be positive," Shana says. "When you get information like that, it's frightening until you realize the value of the knowledge and that you have a head start."

Nuccio assured the Mayfields they were in good hands, providing them with a roadmap of what to expect and offering to contact additional family members about screening. Many families might be hesitant to have their children screened in fear of more bad news, but Jody says the information was empowering.

"Throughout the whole process, we've tried to communicate with Jacob about what was happening, and his siblings have been involved," Jody says. "We told them, 'We are going to St. Jude and here's why: We need to be on the lookout. You remem-

Affecting about 1 in 30,000 children and adults, von Hippel-Lindau syndrome is caused by changes in a gene called VHL. Because the gene plays a role in the life cycle of cells, it can lead to the development of tumors in the eyes, brain, spine, pancreas, kidneys and other areas.

One-stop-shop for VHL

St. Jude is the first and only VHL Alliance-recognized Clinical Care Center dedicated solely to children. "Patients can have their care managed in one place, and our hope is that this will enhance the treatment experience of our patients and families," says Kim Nichols, MD, director of the St. Jude Cancer Predisposition Division.

ber how Jacob got sick? Well, we want to make sure we are not going to get sick."

A STRONG NETWORK

After a diagnosis, St. Jude genetic counselors sit down with patients to answer questions and explain the testing and analysis that's required.

Patients with VHL can develop tumors in the eyes, brain, spine, pancreas, kidneys and other areas. Jacob, now 14, and his siblings undergo annual scans at St. Jude. Depending on the child's age, this tumor surveillance includes imaging of the brain, spine and abdomen; lab work; and a general physical exam. All three children are at risk of developing tumors throughout their lives. St. Jude also provides emotional health screening and coordinates care with primary care physicians.

"Several organs need to be checked and monitored, as opposed to maybe one or two with other syndromes," Nuccio says. "With VHL, some people get tumors in childhood, some get them in adulthood and some never develop tumors — and we don't really understand why."

Monitoring and treating von Hippel-Lindau syndrome requires the efforts of genetic counselors and other specialists such as neurosurgeons, ophthalmologists and endocrinologists. The Cancer Predisposition Program launched six years ago at St. Jude, and now VHL is one of many cancer predispositions the hospital monitors and treats. But the Cancer Predisposition team believed they could do more.

ALLIANCE RELIANCE

The Cancer Predisposition team partnered with former St. Jude employee Kelsey



GINA NUCCIO

Partner in the journey

Gina Nuccio, a genetic counselor in the St. Jude Cancer Predisposition team, has worked closely with the Mayfield family on their VHL journey, providing guidance and support along the way.

Marx, a VHL patient herself, to apply to become a von Hippel-Lindau Clinical Care Center through the VHL Alliance. The alliance works to improve awareness, diagnosis, treatment and quality of life for patients and families affected by VHL.

In September 2020, St. Jude became the first and only VHL Alliance-recognized Clinical Care Center dedicated solely to children.

“As a VHL Clinical Care Center, we can offer expert care with our dedicated colleagues in each of the subspecialties,” says Kim Nichols, MD, director of the St. Jude Cancer Predisposition Division. “Patients can have their care managed in one place, and our hope is that this will enhance the treatment experience of our patients and families.”

Because VHL is so rare, having a dedicated team of physicians also benefits the care providers, who gain valuable expertise and experience with this disease through their work. Nichols lauded the St. Jude team, stating that each person who was asked to participate was glad to join the effort.

With the new VHL Alliance designation, St. Jude is able to serve more patients and families. The alliance also offers a variety of resources to enhance providers’ efforts and improve experiences for families.

“We are honored to partner with St. Jude, and we look forward to the life-changing impact this collaboration will make in the lives of children and families affected by VHL,” says alliance director Chandra Clark.

CONNECTING FAMILIES

In addition to providing holistic clinical care for VHL patients, St. Jude promotes awareness and provides education about the syndrome. In December 2021, VHL will be the focus of the Cancer Predisposition team’s third annual family conference.

The virtual event will feature both national and St. Jude experts who will provide detailed backgrounds of the origins of VHL, disease types, living with VHL, treatment options and surveillance efforts. In addition to attending educational sessions, families can share their stories and interact with each other.

“Many of these families have never met another family with VHL,” Nichols says. “We want them to know they are not alone. There are other families like them with similar stories, and we want to provide opportunities for them to network.”

The Mayfields plan to log in to the two-day conference. They say they look forward to a day where VHL diagnoses are caught even sooner.

“This will help some families have that information before their child develops a tumor or becomes sick. Had I known I had VHL when I was pregnant with Jacob, we would have started testing when he was born,” Shana Mayfield says. “St. Jude is going to keep taking this forward. When people learn they have VHL, they are going to be 100 steps ahead of where we were when we found out.” 

By Maureen Salamon



Prospectors Share the Wealth

When they hit pay dirt, St. Jude miners share their findings—and their high-tech tools—with the world.

SIFTING FOR GOLD sounds thrilling, right? But finding big, valuable nuggets can be a long and tedious process. The same might be true of teasing through reams of DNA data to reveal changes that contribute to cancer and other diseases, as well as to find the best treatments and advance cures.

Scientists at St. Jude Children's Research Hospital work behind the scenes to speed up this genomic sifting in ways that could spell a windfall for children at the hospital and around the world. Developing new computerized tools that essentially act like sieves, researchers can quickly and cheaply analyze huge amounts of DNA data and share the information with others across the globe.

In recent years, St. Jude scientists have developed high-tech tools with snazzy names, such as ProteinPaint, a genomic visualization engine; PeCanPIE, which sifts through millions of genetic variations to find those involved in inherited cancers; CREST, which uses next-generation sequencing data to detect genomic structural variations at base-pair resolution; CONSERTING, which finds DNA duplications and deletions; and other data analysis and visualization tools.

DIGGING DEEP

When children arrive at St. Jude with cancer diagnoses, scientists may genetically sequence samples of their tumors. This testing accomplishes several key goals, precisely identifying the cancer type and helping clinicians make better treatment choices. Crucially, however, the data is combined with information from other patients to provoke breakthroughs that might help far more than one child.

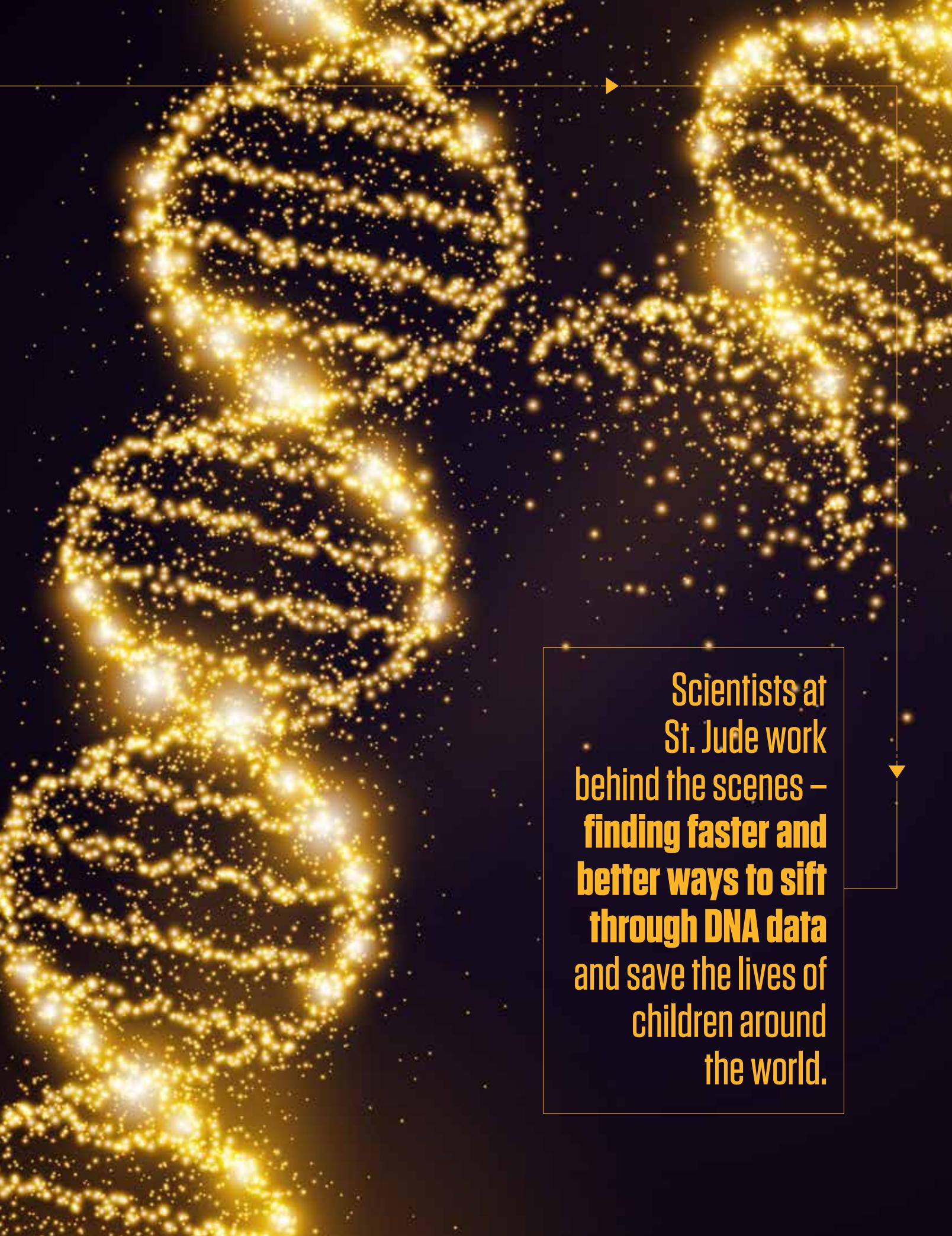
"If you think about the cancer as the

endpoint of the disease, we already get a huge amount of information on what is happening at the endpoint," explains Xiaotu Ma, PhD, of St. Jude Computational Biology, who recently created a new research tool. "We immediately provide every patient with DNA analysis from Day One because it's needed for their tumor diagnosis. But after you start a treatment, you want to know how the cancer is behaving. For that you really need ultra-deep sequencing."

MATHEMATICAL TOOL UNEARTHS MACHINE ERRORS

These research tools seem complex on the surface; yet, the ideas behind them are deceptively simple. The often-catchy names of these tools are also at odds with the serious nature of what they reveal.

Ma's new mathematical tool, called SequencErr, is a prime example. He and his St. Jude colleagues devised the first method to identify and measure errors caused by ultra-deep sequencing machines, which can root out cancer cells hiding among millions of normal cells in patients' tumor samples.



Scientists at St. Jude work behind the scenes – **finding faster and better ways to sift through DNA data** and save the lives of children around the world.



XIAOTU MA, PHD

But these high-tech machines aren't perfect, and sometimes they actually introduce errors into the decoding process. Since each bit of double-stranded DNA fits together like puzzle pieces on a string, Ma's tool knows a mistake has occurred if differences show up in the strands, which are theoretically identical.

"Whenever there is a mismatch within this forward and reverse read, we know it must be from the sequencer," explains Ma, who published a report on SequencErr in the January 2021 issue of *Genome Biology*.

Discovering these machine errors could lead to big payoffs. Ma hopes that SequencErr — offered for free to researchers worldwide — will help doctors find cancer cells that might otherwise escape treatment in patients who have already undergone therapy.

"The tool will help us measure remaining cancer cells and determine if more therapy is needed to prevent relapse," he says.

ANN-MARGARET HEDGES

How do brains explore info?

Xiang Chen, PhD, of St. Jude Computational Biology uses a machine-learning approach called deep learning to improve the study of how people's behavior and environment change the way genes work, a field known as epigenetic research.



XIANG CHEN, PHD

M2A MIMICS BRAIN PROCESS

Another new St. Jude research tool, dubbed M2A, cuts to the deepest secrets of genomics. Created by Xiang Chen, PhD, of St. Jude Computational Biology, M2A uses a machine-learning approach called deep learning to improve the study

of how people's behavior and environment change the way genes work, a field known as epigenetic research.

Putting a new twist on a long-used technique, M2A boosts the value of computers in science — adding to scientists' cancer research toolkit — by simulating the way

Zero in on hidden cancer cells

Facing page: Xiaotu Ma, PhD, of St. Jude Computational Biology, created a new mathematical tool, called SequencErr. It helps scientists identify and measure errors caused by ultra-deep sequencing machines, which can root out cancer cells hiding among millions of normal cells in patients' tumor samples.

human brains explore information.

Recently published in the journal *Genome Biology*, M2A provides a framework to use information on DNA methylation — a process that can lead to conditions such as cancer or heart disease — to understand gene promoters, pieces of DNA that turn a gene on or off.

DNA methylation data are typically used to provide biomarkers that can boost tumor detection. Biomarkers — substances measurable in blood, urine or tissue that may signal disease — can also further whittle down tumor traits that point toward targeted treatments. Scientists worldwide can use the fast, free and reliable M2A tool through St. Jude Cloud, an online data-sharing and collaboration platform.

The researchers have rigorously tested their approach on a variety of adult and pediatric cancers, including leukemias and solid tumors. It takes only about 15 minutes to upload DNA methylation data and receive results tailored to specific DNA proteins called histones.

“What we have done with M2A is create a method for integrating DNA methylation information around promoters to make it more readily interpretable,” Chen explains.

CONGA TANGOES WITH VIRUS DATA

Like the dance it brings to mind, CoNGA is a new tool that can pull together two quite different sets of information in one analysis.

Developed by Stefan Schattgen, PhD, and Paul Thomas, PhD, of St. Jude Immunology; and Phil Bradley, PhD, of Fred



Hutchinson Cancer Research Center, the algorithm may help scientists find new ways to boost people's immune response to sometimes-devastating viruses. The term *algorithm* refers to instructions that tell computers how to transform a set of facts into useful information.

CoNGA combines data from the immune system's nearly limitless T-cell receptors — which zero in on invaders such as viruses and tumors — with data from cells with similar gene expression. Thomas compares CoNGA to a mapping process. He says the tool decodes if groups of cells in both T-cell receptor and gene-expression “spaces” are in the same neighborhoods, “meaning they’re functionally sort of super-related.”

“We can assign little neighborhoods of cells based on those distances in the gene-expression space and do the same thing in the T-cell receptor sequence space,” Thomas explains. “And this gets kind of cool because you form these neighborhoods where every cell has the same group of neighbors.”

Thomas, whose team has developed many techniques for understanding huge sets of data, tested CoNGA on cells from individuals with diverse infection histories, including those who had been infected with Epstein-Barr virus (EBV).

A new way to analyze data

Immunologists Paul Thomas, PhD, Stefan Schattgen, PhD, and a colleague at Fred Hutchinson Cancer Research Center collaborated to develop an algorithm that may help scientists find new ways to boost people's immune response to viruses.

This virus, which causes mononucleosis, “is much more complicated than flu or coronavirus, with many different stages to its lifecycle,” Thomas explains.

“What CoNGA was able to show us was that different T-cell populations had distinct gene-expression profiles specific to each EBV lifecycle stage,” he says. A report on this work recently appeared in the journal *Nature Biotechnology*.

Defined populations of cells common to the flu or EBV, for example, can also be entered into CoNGA to automatically generate patterns. These linkages may lead to discoveries that tease out how the immune system battles these viruses, which can lead to new ways to improve the immune response.

“I think CoNGA will become a standard method of analyzing these datasets,” Thomas says. “Labs everywhere can do it, and we’ve made CoNGA totally open-source and free.” 



By Carrie L. Strehlau

Shining a Light on Mucositis

A new study conducted by St. Jude Nursing Research uses a painless therapy to help children avoid a common side effect of bone marrow transplantation.

LIGHT IS POWERFUL. It cuts through the darkness. It illuminates the soul. It vanquishes the “dark side.” It travels at 186,000 miles per second. For patients undergoing bone marrow transplants at St. Jude Children’s Research Hospital, light also lessens the symptoms of mucositis.

Mucositis is a painful inflammation of the mucous membranes lining the mouth and the digestive (GI) tract. After chemotherapy, sores and ulcers may develop in those areas — causing swallowing problems; mouth, throat and GI pain; breakdown of the stomach lining; and a high infection risk.

Patients use soft-bristle brushing, a special mouth wash and ice chips to combat mucositis. But around-the-clock ice chips are not practical, especially when transplant drugs may be given continuously and overnight.

“One of the most distressing symptoms associated with transplant is mucositis,” says Michele Pritchard, PhD, of Nursing Research. “Patients can develop small sores under their tongues and suffer from throat pain.”

Serious about light therapy

Looking cool in his special sunglasses, Kolsen White undergoes photobiomodulation therapy.

SHINE ON

St. Jude clinicians were determined to take mucositis prevention further.

The solution? Shine a light on it.

Although light therapy, or photobiomodulation therapy, has been used to manage mucositis in adult patients undergoing bone marrow transplant and head or neck radiation, its use in children has been limited.

“We first started talking with dentists familiar with light therapy to determine how we could implement this form of symptom management for our young transplant patients,” says Belinda Mandrell, PhD, of Nursing Research and the study’s primary investigator.

HOW DOES IT WORK?

Chemotherapy or radiation therapy can cause inflammation and cell death. Light therapy helps reverse this process. When absorbed by the cell, the light increases cellular metabolism and decreases inflammation.



BELINDA MANDRELL, PHD

St. Jude Nursing Research staff developed a study designed specifically for bone marrow transplant (BMT) patients.

“We developed this as a prevention, not as a treatment,” Mandrell says. “We start light therapy on the first day of admission as a preventive measure.”

The researchers want to see whether light therapy reduces oral mucositis in children and adolescents. All study participants are getting blood stem cell transplants from matched or unmatched donors. The researchers also want to explore whether the treatment works for those who receive their own cells as part of the transplant process.

SWIFT AND PAINLESS

The daily low-level light therapy is given both inside and outside the mouth for one



minute per site. The child receives treatments until engraftment of the new bone marrow occurs or for 20 days, whichever is earlier.

Patients can watch TV, read or play games during the light therapy.

“So much of cancer treatment may cause discomfort or pain,” Pritchard says. “This doesn’t cause pain. It’s like a flashlight on their cheek.”

Older patients may hold the light probe themselves, taking an active part in their own therapy.

“It’s reassuring to caregivers that this can be a passive treatment for their children, especially if they’re not feeling well,” Pritchard says.

For those who are school age and older, the light therapy may be given using a probe that resembles a lollipop that can be held in the mouth. Small dental light probes may be used under their tongue or along the gum line.

“We ask the patient their level of pain before and after the treatment. We also document their need for nutritional support, blood and oral cultures,” Pritchard says. “We hope this helps decrease days in the hospital and reduces associated blood infections.”

“This light therapy study shows that we will go to any length — and will try even seemingly unusual techniques — if it can make those hardest days easier for our patients.”

— Brandon Triplett, MD



BRANDON TRIPLETT, MD

Preventing problems

Susan Ogg, RN, of Nursing Research delivers light therapy to patient Jennings Palmer.

The protocol has been active for about a year, with no reported toxicity or adverse events.

“Sometimes a child might complain that something hurts before we can see anything going on in their mouth,” Pritchard says. “When we treat that area, they say it really helps with the pain.”

MORE THAN PREVENTION

The team now has enough data to recommend light therapy for patients who receive radiation to the head and neck as well as for other bone marrow transplant patients. Early results have shown the treatment to be successful in preventing serious mucositis.

“I’d like to see light therapy given as a supportive care option not only for mucositis prevention among BMT patients, but as therapeutic treatment for patients who develop mucositis,” Mandrell says. “Additional projects include implementation in wound healing.”

Although providing the therapy might sound easy, it requires specialized equipment and an experienced team of clinicians.

“Our team sees these patients every day to deliver therapy,” Pritchard says. “We couldn’t do this without our great bedside nurses.”

Brandon Triplett, MD, of St. Jude Bone Marrow Transplantation and Cellular Therapy says the study illustrates the staff’s dedication to the children of St. Jude.

“Transplantation is one of the most powerful cancer treatments we have. Due to that intensity, it’s also one of the most difficult treatments,” he says.

“To me, this light therapy study shows that we will go to any length — and will try even seemingly unusual techniques — if it can make those hardest days easier for our patients.” 



A Global View of ALL

By Keith Crabtree, PhD



In the U.S., the five-year survival rate for childhood acute lymphoblastic leukemia is 90%. St. Jude takes steps to improve the outlook for children with that disease in China, Brazil, Egypt and beyond.



U.S.



BRAZIL



EGYPT



CHINA

Stepping Stones to Cures

THE LITTLE GIRL screamed and shook her head, but the nurse was undeterred.

She intended to calm the child and access the port-a-cath, a device used to deliver life-saving chemotherapy. But first, she'd need the child to sit still.

Embarrassed, the mother pulled a toy from her bag, but her daughter pushed it away.

It was "dex" week.

Dex is dexamethasone, part of the treatment regimen for children with acute lymphoblastic leukemia (ALL), a cancer of the blood and bone marrow. Children receive this steroid and a chemotherapy drug called vincristine in intervals, called pulse therapy, during the second year of treatment.

What's the quality of life for patients during that time?

"Not good," says Ching-Hon Pui, MD, Oncology chair at St. Jude Children's Research Hospital.

A standard of care since the 1970s, this dex-vincristine combo also has repercussions that extend far beyond the treatment phase. The problems include personality and mood disturbance; sleep problems; metabolic syndrome, which is linked to heart disease and Type 2 diabetes; and peripheral neuropathy, a type of nerve damage.

"The side effects from the dexamethasone and vincristine are not negligible," says St. Jude oncologist Hiroto Inaba, MD, PhD, principal investigator of Total Therapy 17, a St. Jude clinical trial for ALL.

SETH DIXON



CHING-HON PUI, MD

As a result, Pui — and an esteemed group of researchers in China — decided to look into the status quo and possibly change it.

COLLABORATION IS KEY

In the U.S., children with ALL have a survival rate of 90%. Yet, children in low- and

middle-income countries, such as China, fare far worse.

In 2018, St. Jude Global embarked on a mission to change that scenario. A signed accord and research partnerships with China count among its many achievements.

Even before the global program began, Pui had been working for decades to improve outcomes for children with leukemia in China. Since 2006, he has spearheaded an annual teaching conference on childhood cancer in Asia. And, thanks to his efforts, ALL became the first childhood disease covered by the Chinese New Medical Insurance Policy—providing hope to thousands of underprivileged children in China.

Today, Pui serves as medical director of the St. Jude Global China Program. Under the hospital's new strategic plan (see related story, page 3), Pui will continue to play an important role in improving treatment and research of

**Ching-Hon Pui, MD,
collaborated with
researchers in China to
conduct a clinical trial
with 6,108 patients — the
largest randomized
trial in pediatric
leukemia history.**

front-line ALL studies in collaboration with the Chinese Children's Cancer Group.

LIFTING THE BURDEN

St. Jude children and families love Pui. He's more than willing to do a magic trick or tell a good joke — or a joke good enough to elicit a groan — to make connections and quell treatment anxiety.

Understandably, some patients and families dread steroid pulses. Pui wondered if prolonged treatment with these drugs was necessary.

To find out, he collaborated with researchers in China to conduct a clinical trial with 6,108 patients — the largest randomized trial in pediatric leukemia history.

The scientists found that the dexamethasone therapy could be safely eliminated in low-risk patients beyond the first year of treatment, effectively quashing

toxic side effects linked to this regimen.

"Many parents will be very happy," Pui says.

Additional studies will be needed to determine if this regimen can be omitted for patients in standard-risk groups.

"The weeks that they get this medicine are terrible," Pui says. But the burden may be lifted for a substantial number of patients and families.

TAKING AIM AT RELAPSES

Pui's lifetime achievements in the fight against childhood leukemia are heroic, although he downplays his contribution.

His numerous projects act as stepping stones to cures and improved quality of life for children with this life-threatening disease.

In findings reported earlier this year, Pui also joined scientists in China to look at central nervous system or CNS relapse in ALL patients.

They found three factors contributed to a reduced risk of CNS relapse: treatment timing, the timing of dexamethasone treatment and the lumbar puncture for intrathecal (within the spine) therapy; total intravenous anesthesia, a type of sedation used during spinal taps; and flow cytometry analysis, a test for the presence of leukemic cells in the cerebrospinal fluid.

"We have a fruitful collaboration with the Chinese Children's Cancer Group," Pui says. "No single institution or even collaborative study group can enroll enough patients to conduct definitive randomized non-inferiority clinical trials, which requires thousands of patients to prove that treatment can be safely reduced, especially among those with low-risk leukemia. By working together, we achieve results that benefit children across the world." 

Refinement Road

WHEN ST. JUDE oncologist Raul Ribeiro, MD, was a boy, he worked in a Brazilian pharmacy. His uncle Jair was a pharmacist.

Ribeiro rode his bike to make deliveries.

He understood the power of medicine to better people's quality of life. But he couldn't have known that one day he would advise hitting the brakes on the intensity of chemotherapy to save lives.

Ribeiro is committed to improving the care of children with ALL by narrowing the gap in outcomes between high-income and low- to middle-income countries.

"When I came to St. Jude," he says, "I compared the survival rates in the U.S. with other countries. I had this eye for disparity. I always thought, 'How can we help decrease the gap?'"

Indeed, high-intensity therapy boosted



Meanwhile, in Recife

St. Jude work in Brazil led to a second successful clinical trial in Egypt.

cure rates for ALL in developed countries, an upward trend that began decades ago.

"When we use intensive therapy in a region with limited resources, we see the opposite trend," Ribeiro says. Children,

for example, die of infection in low- and middle-income countries because the supportive care resources needed to manage complications from high-intensity regimens aren't available.



RAUL RIBEIRO, MD

A STAND-OVER-THE-CROSSBAR MOMENT

Years ago, oncologists in Recife, Brazil, stopped on the road and put the kickstand down to think about the route. More children with ALL than expected were dying early deaths. Could reduced-intensity therapy — similar to that used in high-income countries in the 1990s — make a difference in the cure rate? Could clinicians identify low-risk ALL patients who were likely to benefit from reduced-intensity therapy?

Detecting minimal residual disease, or MRD, early in treatment with flow cytometric assay is key, but this technology can be complex and expensive. So, St. Jude developed a simple and inexpensive method.

Results of that study showed that lower-risk kids with B-cell ALL, the most common type of ALL, had excellent outcomes in response to low-intensity therapy.

The Recife protocol was used successfully for a clinical trial with many more participants at the Children's Cancer Hospital of Egypt in Cairo. The results from

The results from Recife and Cairo point the way for physician-scientists in low- and middle-income countries to take advantage of the many benefits of risk-directed therapy, such as avoiding overtreatment, reducing toxicity, and decreasing the likelihood of long-term side effects.

Recife and Cairo point the way for physician-scientists in low- and middle-income countries to take advantage of the many benefits of risk-directed therapy, such as avoiding overtreatment, reducing toxicity, and decreasing the likelihood of long-term side effects.

PEDALING FASTER

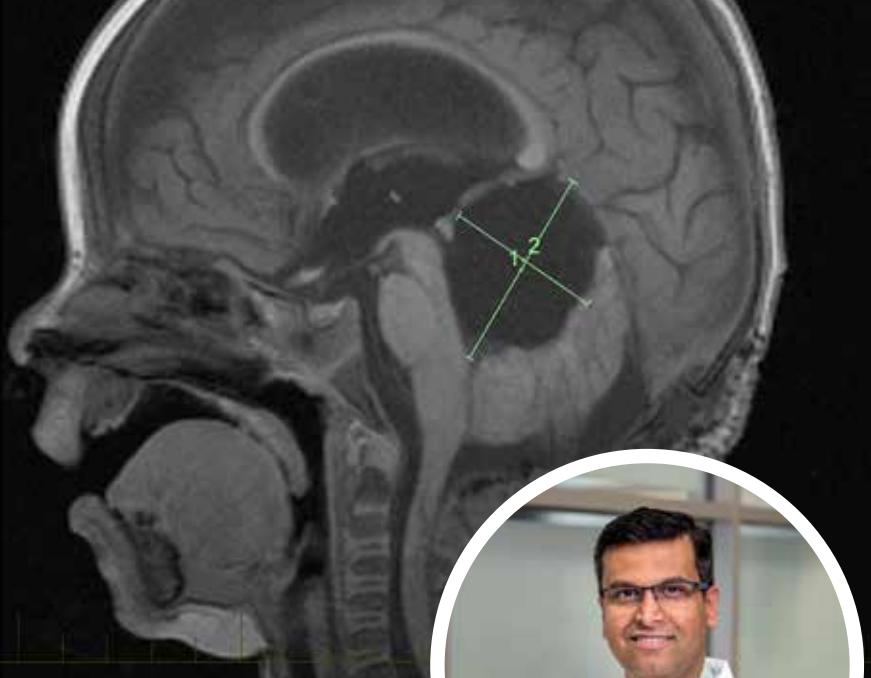
A national protocol in development in Brazil will follow the Recife procedures.

Ribeiro, who has cared for children from around the world for more than 30 years, makes a weekly call to the care team in Brazil to talk about cases. He says he has learned a few lessons along the way.

"You cannot simply transport a protocol from a developed country to a developing one and expect the results to be the same," Ribeiro says. The disparity in supportive care, among other factors, will sabotage those efforts.

Having an eye for disparity and the ingenuity to find a different way of doing things can make the road to refined treatment for ALL less bumpy. ■

Research Highlights



SANTHOSH UPADHYAYA, MD

Learning more about ATRT molecular groups

ATYPICAL TERATOID RHABDOID TUMOR (ATRT)

is a rare childhood brain tumor. Scientists recently learned that it has at least three biologically different groups: ATRT-MYC, ATRT-SHH and ATRT-TYR.

Scientists looked at data from the SJYC07 and SJMB03 clinical trials for the three groups.

They learned that ATRT-TYR usually occurs in children under age 3 years and is less likely to spread.

ATRT-SHH also occurs in very young

children and is likely to have already spread at diagnosis.

Children with ATRT-TYR had the best overall response. Yet, the other groups had similar outcomes if the disease had not spread.

About a third of the children had a SMARCB1 mutation in their blood. These children tended to develop ATRT at a younger age and were more likely to have ATRT-SHH.

"We have made giant strides in understanding the molecular basis of ATRT, but substantial progress is warranted before treatment decisions are made on the basis of different molecular groups," said Santhosh Upadhyaya, MD, of St. Jude Oncology.

Clinical Cancer Research published a report on this study.

Roussel elected AACR fellow

MARTINE ROUSSEL, PHD, a molecular oncologist at St. Jude, has been elected to the 2021 Class of Fellows of the American Association for Cancer Research.

Roussel is a member of the Department of Tumor Cell Biology at St. Jude. Her research into childhood brain tumors, conducted over the past 50 years, has led to new avenues of treatments and therapies to maximize cures. She has made landmark findings in molecular oncology, cell cycle control and translational development of treatment strategies for pediatric medulloblastoma.

Roussel, who holds the St. Jude Endowed Chair in Molecular Oncogenesis, was previously elected to the American Academy of Arts and Sciences and the National Academy of Sciences.



MARTINE ROUSSEL, PHD

Research Highlights

SETH DIXON



Excellent outcomes reported for high-risk Hodgkin therapy

RESULTS ARE IN on the first frontline clinical trial to use targeted therapy for high-risk pediatric Hodgkin lymphoma. The study showed that the addition of brentuximab vedotin achieved excellent outcomes, reduced side effects and allowed for reduced radiation exposures.

The study was the result of work by a multi-site consortium dedicated to pediatric Hodgkin lymphoma.

Brentuximab vedotin has already been approved to treat adults with Hodgkin lymphoma. The drug is currently being incorporated into other national trials for children with the disease.

Overall three-year survival for the trial was 99%. Of the 77 patients enrolled in the study, 35% were spared radiation. When radiation was needed, it was precisely tailored, and doses were reduced when possible.

"Being able to offer Hodgkin lymphoma patients a targeted therapy in the frontline setting is an exciting development," said Melissa Hudson, MD, St. Jude Cancer Survivorship Division director. "We are constantly learning from research and applying new findings to the next iteration of clinical trials."

The *Journal of Clinical Oncology* published a report on this work.



Great news for retinoblastoma patients

MOST PATIENTS with the eye cancer retinoblastoma are infants or toddlers when their cancer is found. With treatment, 96% survive.

How do they fare years later at home and at school? An earlier St. Jude study indicated their early learning and life skills declined from diagnosis to age 5.

Scientists tested many of these survivors five years later. The results were more upbeat. By age 10, almost all were within the normal range in those areas. That included children who had one eye removed, although they did not make up quite as much ground in the areas of learning, thinking and memory.

"The findings show we all need to be aware of factors that put children at risk for difficulties later," said Victoria Willard, PhD, of St. Jude Psychology. "It highlights that all young children with retinoblastoma may benefit from early intervention to promote growth and development."

The *Journal of Clinical Oncology* published a report on this work.

(From left) Monika Metzger, MD; Matthew Krasin, MD; Melissa Hudson, MD



VICTORIA WILLARD, PHD

Research Highlights



HEATHER CONKLIN, PHD

Socioeconomic status affects cognitive outcomes

CHILDHOOD CANCER and its treatment can result in cognitive struggles. To study the risk factors, scientists looked at social and economic issues in children with brain tumors treated with radiation.

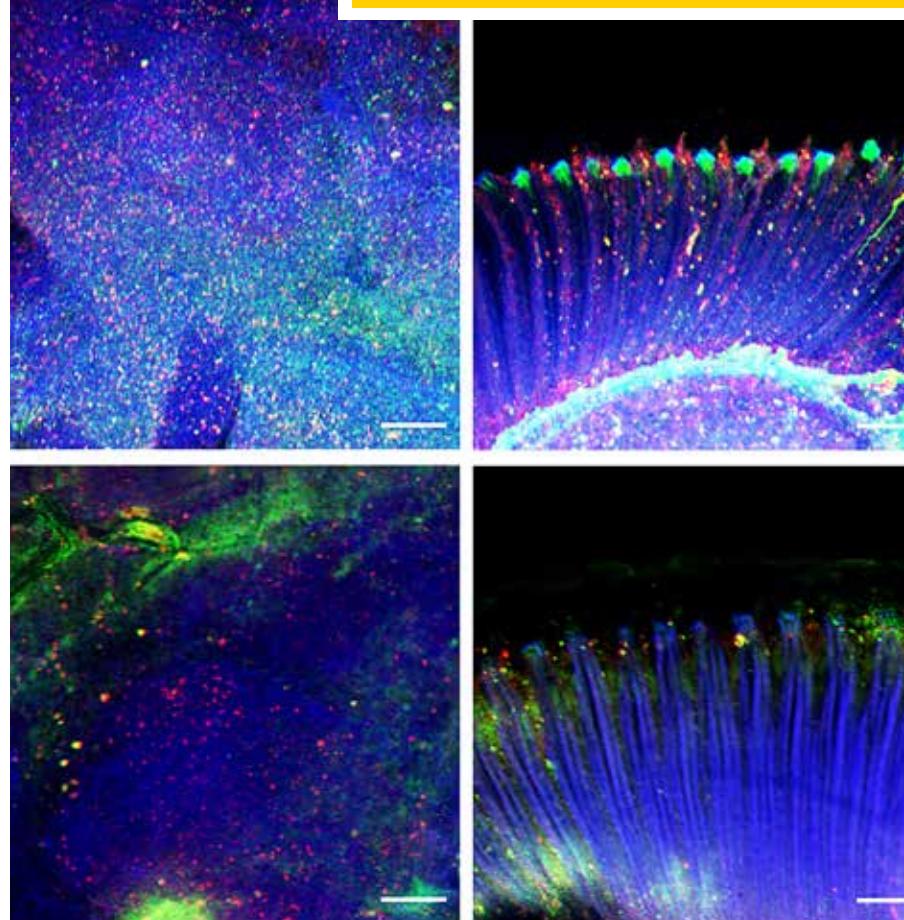
These patients have the greatest risk of cognitive problems. For 10 years, scientists followed a group of St. Jude patients who had conformal radiation therapy.

Researchers looked at factors that included the parent's job, education level and whether it was a single parent home. The children were from different backgrounds.

The findings show social and economic status is linked to IQ, academics, attention and self-care skills before treatment. This gap widens over time.

"What was most surprising was that for some measures, the contribution of socioeconomic status was even greater than age at treatment, which has typically been the biggest risk factor," said Heather Conklin, PhD, of St. Jude Psychology.

Neuro-Oncology published a report on this work.



Signals from muscle protect from dementia

HOW DO DIFFERENT parts of the body communicate? St. Jude scientists are studying how signals sent from skeletal muscle affect the brain.

The team studied fruit flies and brain cell models called organoids, focusing on the signals muscles send when stressed. The researchers found that stress signals rely on an enzyme called Amyrel amylase and its product, the disaccharide maltose.

The scientists showed that mimicking the stress signals can protect the brain and retina from aging. The signals prevent the buildup of mis-

folded protein aggregates. Tailoring this signaling may help combat conditions such as age-related dementia and Alzheimer's disease.

"We found that a stress response induced in muscle could impact not only the muscle but also promote protein quality control in distant tissues like the brain and retina," said Fabio Demontis, PhD, of St. Jude Developmental Neurobiology. "This stress response was actually protecting those tissues during aging."

Cell Metabolism published a report on this work.

By Katie Chinn Weyer



Katie Chinn Weyer is a math and science teacher as well as a track and cross-country coach. She enjoys spending time with her husband, Nick, and their sons, Ben (at left) and Jack.

Life after St. Jude: ‘Cured’ Is Only the Beginning

One childhood cancer survivor learns to navigate life – and her health – after treatment.

CURED. For someone with cancer, the word elicits images of exultation, relief and celebration. But for most childhood cancer survivors, “cure” is not the end of the journey.

When I completed Hodgkin lymphoma treatment at St. Jude Children’s Research Hospital, I thought, “This will be great! I’m done.”

Reality hit when I returned for follow-up appointments in the After Completion of Therapy Clinic. That’s when I truly comprehended the long-term side effects of the treatments that had saved my life. These include neuropathy; cold sensitivity; issues with my thyroid and esophagus; a high risk of breast cancer and heart problems; and poor lung function — an unwelcome surprise for a former competitive runner.

How would I maintain my health after leaving St. Jude?

Unfortunately, many clinicians don’t understand the health implications of childhood cancer treatments. St. Jude prepared a summary to explain the therapy I received and the tests I needed based on my risks. That survivorship plan is one of the most important documents I own because it helps me navigate the real world.

Sometimes health care providers would listen to me and follow the testing schedule; when I encountered those who would not comply, I learned to move on. With time and persistence, I assembled a health care team I trust.

Many people have said to me, “I had no idea that being a cancer survivor was so involved. I thought once you were done, you were done.”

As a result of those comments, I am motivated to spread the word: The long-term effects of cancer can be scary, but patients, providers and the public need to know about them and face them so that we can maintain survivorship.

Occasionally, people will say, “Oh, I bet you wish you had never had cancer.” Well, of course there would be parts I would change, but if I hadn’t had cancer, I wouldn’t know how great St. Jude is. I have many long-term effects of treatment, and they will always be a part of me. Yes, my cancer experience defined my life, but I wouldn’t change it — because it is my story. 

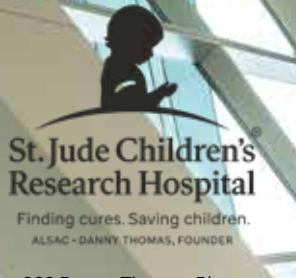
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Hear the voices of childhood and adolescent cancer patients, families, and care providers.



Interested in sharing your story? Contact us at together@stjude.org.



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Taking Science to New Heights

THE SHEER SCALE of the St. Jude Advanced Research Center hints at the power of science to transform the human condition.

During the summer of 2021, scientists in the fields of developmental neurobiology, immunology, cell and molecular biology, gene editing, metabolomics, advanced microscopy, epigenetics and genomics began to move into the facility.

Designed to foster collaboration and innovation, the building contains nearly 1.8 million square feet of sheetrock, the city's tallest glass window, and enough rebar to stretch from Memphis to Montreal. In spite of its floor-to-ceiling windows and state-of-the-art technology, the power of this building resides in the hearts and minds of the scientists who work there. In the coming years, work conducted within these walls will accelerate progress globally.