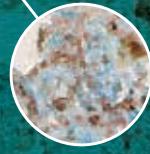
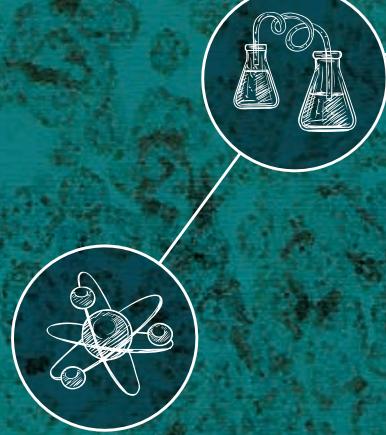
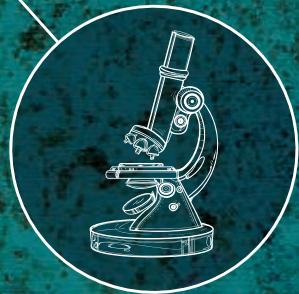
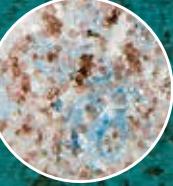
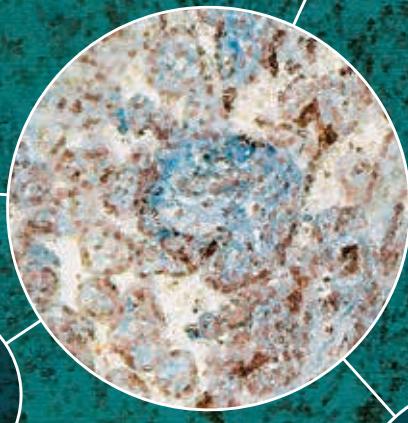
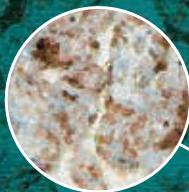
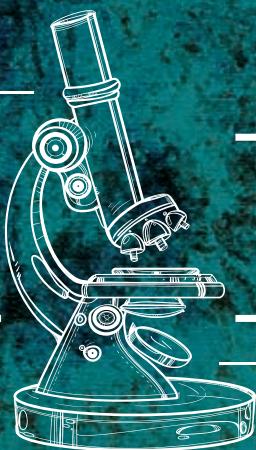


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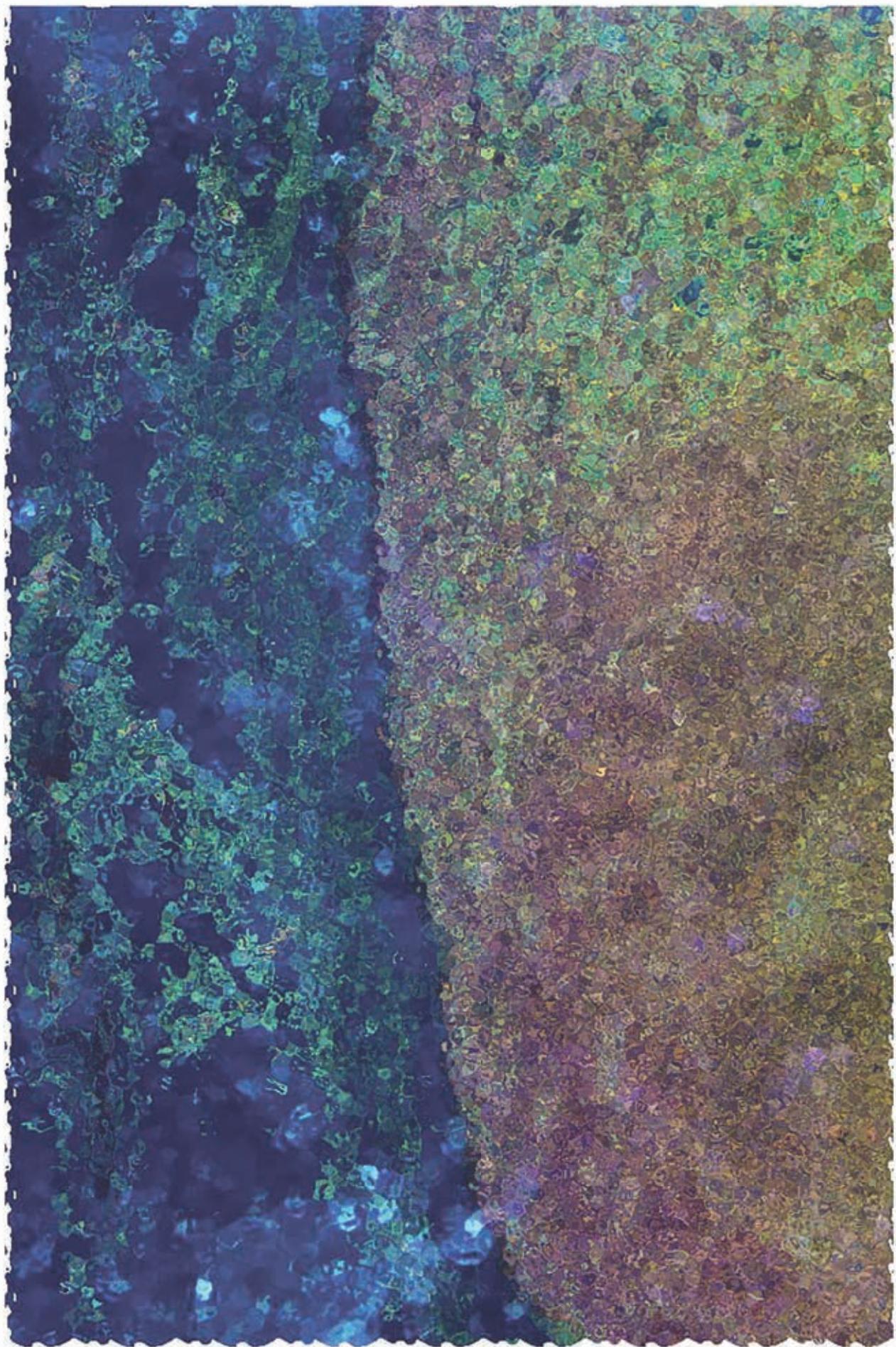
the art & science
of diagnostic medicine



ARUP[®]
LABORATORIES

SUMMER 2018

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Magnify

The Art and Science of Diagnostic Medicine

Have you ever approached a Claude Monet painting, stopping only when you are inches from the canvas? The whole becomes the sum of its parts: a brush stroke, minuscule touches of color, the interplay of shapes. In diagnostic medicine, pathologists approach the patient in a similar way, zooming in and magnifying the infinitesimal details that make up the patient—a blood cell, the spiral of a DNA strand, a gene variant, a foreign bacteria or a virus.

Through these microscopic clues, pathology experts assist in the detection, diagnosis, treatment, and management of human diseases and conditions. Approximately 70 percent of patient-care decisions are based on in vitro diagnostic test results produced by a clinical laboratory.

Magnify focuses on ARUP Laboratories' current role in diagnostic medicine, as well as its drive for pushing knowledge and discoveries forward. As one of the country's two largest nonprofit, national reference laboratories, ARUP has entrepreneurial roots and strong ties to academic medicine that guide its unique business approach. (It is a nonprofit enterprise of the University of Utah and its Department of Pathology.)

This approach includes emphasis on education, strict adherence to evidence-based knowledge, and an environment that promotes collaboration and thus accelerates innovation. The stories among these pages will allow readers to see for themselves, zooming in and back out, ARUP's patient-focused and market-facing dynamics at work.

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ARUP Leadership— The Pros and Cons: Should Hospitals Sell Their Labs?





Hospital executives increasingly face substantial offers to outsource or sell their lab services to commercial vendors. ARUP CEO Sherrie Perkins, MD, PhD, and Julie Altwies, chief business development officer, discuss the pros and cons from short- and long-term perspectives.

Why are hospitals selling their labs to commercial vendors such as LabCorp and Quest?

S— Right now there is a lot of fear and uncertainty in the laboratory industry. Large commercial vendors are leveraging and capitalizing on this uncertainty and buying up hospital outreach programs and hospital labs.

J— They're making promises about turnkey solutions that, in reality, provide more benefit to the commercial vendor than the hospital lab. This sudden infusion of money is often too hard to resist, given the pressure hospitals are under with declining reimbursement and narrowing margins.

S— The first few years may be good, but then these hospital labs are at the mercy of the vendor.

What is the value of keeping the lab in-house, from a financial perspective?

S— While outsourcing may provide an infusion of cash into a health system, it comes with crucial trade-offs. There is a financial advantage to keeping lab services in-house because a health system retains the ability to contain costs. As we move from a decades-old, fee-for-service model that emphasizes volume to a model that places importance on quality outcomes with value-based reimbursement, it is essential to ensure that patients get the right tests for the best medical outcomes at the lowest cost.

J— Commercial labs survive on volume; they must continue to grow revenue to keep stakeholders happy. Acquisitions and lab-management arrangements offer a quick way to achieve that goal. As more physician practices come under the umbrella of a health system, commercial labs risk losing those practices as clients unless they acquire or take over management of the health system lab.

S— Health systems, on the other hand, are committed to the mission of caring for patients and must consider overall costs, even if it means performing fewer tests in the laboratory.

J— Values are often misaligned when a health system sells its in-house laboratory.

From a patient-care perspective, what is the value of keeping lab services in-house?

S— It's not just about cost. Selling your lab impacts patient care. To maintain the best patient care is to keep the testing as close as possible to the patient. Oftentimes when a lab is sold, testing goes to other sites and turnaround times increase. Also, selling the lab doesn't allow for close focus on utilization management or the development of lab practices to improve patient care.

Most people overlook the fact that the laboratory has more touchpoints with patients than any other area. While lab services may make up only 3 to 4 percent of the hospital's overall costs, they contribute to more than 80 percent of the information in a patient's EMR [electronic medical record]. This alone is a compelling reason for a hospital to maintain control of its laboratory services.

J— Good patient care relies on lab services that are high quality, easily accessible, and reported quickly. When specimens are lost or compromised, the impact on patients can range from the inconvenience of having specimens recollected or cancellation of an outpatient visit to potential delays in diagnosis and treatment.

S— Once your lab operations are off-site, it is very difficult to change ordering patterns and communicate with clinicians about appropriate testing. You lose that close communication that makes a healthcare team effective. The lab and pathologists are part of that team.

J— Patient satisfaction is a key metric for health systems. Selling your lab means turning your brand over to an outside entity. Internal control over testing quality and customer service is turned over as well and may impact patient satisfaction.

"We can help laboratories quantify their short- and long-term value in terms of revenue potential and impact on patient care."

Julie Altwies, Chief Business Development Officer

What should lab personnel know about the prospect of their labs being sold?

S— The decision to outsource or sell is often made at the executive level, and laboratory personnel are sometimes the last to find out. Even when they do know, laboratorians may not fully understand the value of the lab from a financial perspective and can't communicate their value to the executives.

Often, nonlaboratory executives see lab testing as just another commodity without fully understanding what value their lab brings to the overall healthcare organization.

J— When labs are sold, employees are often let go or must reapply for their positions. Management often gets replaced.

What can lab management do?

J— Be proactive. Laboratory professionals need to articulate the value the lab delivers to the health system beyond test results. Develop a laboratory value proposition and make sure members of the health system executive team hear it. The key is to connect the dots between the laboratory, providers, and their patients in ways that drive outcomes and cut costs.

S— Also, make sure you are represented on patient-care teams, where decisions are being made collectively by a variety of providers.

How are hospital physicians affected?

S— Physicians depend on quality lab tests that provide results they can trust. In organizations with laboratory stewardship programs, it's not uncommon for the lab staff to work with clinicians on the front end to help ensure appropriate tests are ordered, and then on the back end by assisting with proper interpretation of test results.

J— Commercial labs are volume driven. Performing fewer tests does not support the commercial lab model.

In order to keep their stakeholders happy, commercial labs are incentivized to increase revenue by growing volume. Therein lies the difficulty with commercial labs offering lab stewardship services. They may try to talk the talk, but they don't walk the walk.

How difficult is it for a hospital to buy back its lab?

J— Very difficult. For one, the hospital cannot compete for outreach business for the length of the contract—typically five years. It is costly and complex to bring these services back in-house once they've been sold.

"Our roots are as an academic-medical entity, so our values are to help and to share knowledge. We want a partnership with—not ownership of—our clients' laboratories."

Sherrie Perkins, MD, PhD, ARUP CEO

Once the contract is up, the hospital must actively market and sell its services to community-based physicians, a process that typically requires a year to 18 months before a new contract is secured.

From a management perspective, the commercial lab will downsize the lab staff, letting experienced and valuable personnel go. To find trained personnel and restaff the laboratory is difficult. The cost of "lost personnel" is undeniable, with long-term implications.

Last, the disruption in reagent contracts or rental agreements means renegotiating agreements at current market rates.

How can ARUP help increase the value of hospital labs?

J— Hospital labs are inherently valuable, but this value is a well-kept secret in many organizations. We can help laboratories quantify their short- and long-term value in terms of revenue potential and impact on patient care.

S— We can provide decision support on many different levels and help our clients improve operational efficiencies, grow outreach margins, or engage in laboratory stewardship to address and reduce misutilization.

J— It's about giving recommendations that are both actionable and quantifiable.

S— Our roots are as an academic-medical entity, so our values are to help and to share knowledge. We want a partnership with—not ownership of—our clients' laboratories. ■



"Born This Way" by Logan Madsen

In the painting, a colorful DNA helix streams out of the palm of Logan's hand—a fist surrounded by auras of blue and green, as well as light. In reality, this young man's four-fingered hand is typically gripping a paintbrush, applying rich strokes of acrylic paint to canvas, as Logan Madsen attempts to capture in art the unique characteristics of his body as well as his personal struggles with the way he was born.

"I'm expressing pride in my challenges," says Logan of this painting, titled "Born This Way."

"It's a forceful, almost angry pride, in looking different and being different and having a point of view that no one else has."

A Singular DNA Destiny—Decoding the Beauty and Hardships of Life

While all DNA is unique, Logan's is especially singular. He was born with not one, but two rare genetic conditions: Miller syndrome and primary ciliary dyskinesia (PCD). Miller syndrome causes facial and limb malformations—intelligence is not affected. PCD is a rare lung disorder that affects the cilia, the tiny, hair-like structures that line the airway and carry mucus and bacteria toward the mouth to be coughed or sneezed out. PCD interferes with Logan's breathing and makes him prone to respiratory infections.

Logan is one of only 30 people documented to have Miller syndrome. His sister, Heather, is one of those 30. She was born with PCD, as well. The chance of two siblings being born with these two rare conditions? Approximately one in 10 billion. The odds of winning the lottery are significantly higher.

Because of these unlikely odds, Logan's family (his mother Debbie, his father Terry, and Heather) caught the attention

of geneticist Lynn Jorde, PhD, and his colleagues. "Ever since we learned about Debbie's children in our genetics clinic in 1981, we were all curious about their condition. The syndrome was just being defined by Marvin Miller," recalls Jorde, who is now chairman of the University of Utah Health's Department of Human Genetics.

As DNA sequencing technology evolved and its cost dropped significantly, these scientists' thoughts returned to Logan and his family. "We thought, why not sequence a family that has a disease with a cause we don't know, since the sequencing might reveal the cause of the disease?" says Jorde. (Years after learning about Logan and Heather, Jorde would end up on a blind date with their mother, Debbie, and eventually marry her. It was likely the only first date in which the words "postaxial acrofacial dysostosis" popped up in conversation.)

In 2010, sequencing ultimately identified the genetic "errors" that cause PCD and Miller syndrome. This discovery was also a seminal step forward in human genetics because it revealed the human mutation rate, which helped pave the way for the Utah Genome Project. (See page 8.)

The team also learned that Debbie carries a disease-causing version of the cystic fibrosis gene, so both her children carry it as well. However, since their father is not a carrier, the children have only one copy and therefore do not have cystic fibrosis.

The chance of having all three of these characteristics—PCD and Miller syndrome gene variants and the cystic fibrosis gene variant—is one in 300 billion. "There is no one else like Logan and Heather on the planet," says Debbie. Heather and Logan also have autism, which was diagnosed when they were both in their twenties.



"I knew that if I couldn't find happiness, how could they?"

Debbie Jorde

Unsolved Cases?

The Detective Work of the Utah Genome Project Solves the Mysteries of Inherited Diseases

You can see the mother with breast cancer. The brother who got colon cancer. The neighbor whose heart suddenly stopped due to a heart arrhythmia.

What you cannot see is the gene variant, or mutation, associated with each of these diagnoses. For more than 50 years, University of Utah (U of U) Health geneticists have been at the forefront of discoveries about our genetic makeup and what happens when things go awry. They have identified genes and risk factors linked to more than 30 conditions.

Catalyzing these discoveries is the university's Utah Genome Project, a large-scale genome sequencing and analysis initiative, in combination with the Utah Population Database (UPDB)—a treasure trove of genealogical data. The UPDB includes health and medical information from more than 10 million people in thousands of large pedigrees. It's a holy grail for research, attracting faculty from around the world to the U of U.

The project supports genetic research on more than 50 diseases and involves investigators from nearly every department in the School of Medicine. It is also closely affiliated with the Penelope program, a collaboration between the U of U's Department of Pediatrics and Primary Children's Hospital

dedicated to finding diagnoses for the undiagnosed. If a child is born with a suspected genetic condition, each family member's genome is sequenced to figure out if the condition stems from a gene variant. "This allows for a diagnosis, and, in some cases, a treatment option," says Lynn Jorde, PhD, executive director of the Utah Genome Project.

A Breakthrough: Determining the Human Mutation Rate

In 2009, geneticists at the U of U sequenced the genomes of an entire Utah family. It was the first time ever that an entire human family had this done, and it paved the way for the Utah Genome Project. The data contributed to the discovery of the genetic variants involved in Miller syndrome and primary ciliary dyskinesia. (See accompanying article.)

In addition, by studying this family's genes, scientists were able to estimate the human mutation rate, or how often mistakes occur across the entire genome. "We wanted to get an idea of how long it would take for genetic differences to arise," explains Jorde. Since 2009, the genomes of many more families (involving more than 7,000 people) have been sequenced.

"There are 3 billion base pairs in one person's genome, so even sequencing one family gives you quite a bit of information," says Jorde.

One of Jorde's postdoctoral fellows, Chad Huff, PhD (now a faculty member at MD Anderson Cancer Center in Houston), came up with the algorithm that calculates

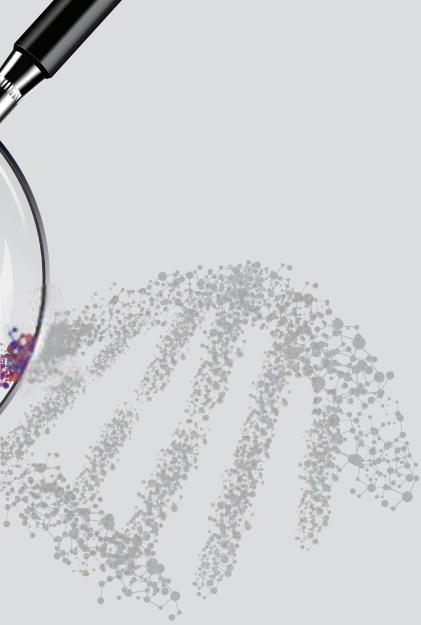
the mutation rate. The calculation's accuracy has stood the test of time.

The Utah Genome Project draws expertise from across the U of U, including from ARUP Laboratories, which collaborates with the project by helping to translate new genetic findings into diagnostic tests.

"The future includes more and more utilization of genetics to help guide patient care," says Karl Voelkerding, MD, medical director of Genomics and Bioinformatics at ARUP and a Utah Genome Project Scientific Advisory Board member.

"As stewards of patient care, we must consider how to integrate more genetic testing, especially to screen populations at risk for specific diseases, and ask how we can economically accommodate it within a healthcare system," says Voelkerding, a pathology professor at the U of U School of Medicine.





"As stewards of patient care, we must consider how to integrate more genetic testing, especially to screen populations at risk for specific diseases, and ask how we can economically accommodate it within a healthcare system."

Karl Voelkerding, MD, Medical Director of Genomics and Bioinformatics (left)



"Look Me in the Eye" by Logan Madsen

Miller syndrome is an autosomal recessive genetic condition caused by mutations (changes in the DNA code) in the *DHODH* gene. Children inherit Miller syndrome when each of their parents has a mutation in the *DHODH* gene, which results in the children receiving two copies—a double dose. PCD is associated with a recessive gene as well and must be passed on by parents who are carriers.

"Although there are many rare genetic disorders, collectively they may be present in approximately 3 percent of the world's population," says Chris Miller, one of ARUP's 16 genetic counselors.

"There are several benefits of determining the cause of a rare disorder. Parents who have children with the same disorder can be connected, even internationally, with one another and support each other through life's journey," says Miller. Determining the cause of their child's disorder enables parents to learn their chance of having another child with the same condition and allows researchers to begin developing targeted treatments for the condition.

Born This Way

Buried in Logan's DNA is also the capacity to develop arresting art (his family tree has been traced back to Vincent van Gogh), a lively intellect, and a deeply compassionate nature. Perhaps because tasks of daily life take longer and are more arduous for him, he observes the activity around him with a keen eye.

For a while, a parade of ants marched into Logan's kitchen, until he finally put a stop to it. "Have you ever noticed how an ant acts once it's removed from the group, from its community of fellow ants?" he asks. "It's confused, then stands up on its back legs, and looks around, like 'where did everyone go?' I felt bad for it," said Logan. "I took that one outside."

In his small apartment/studio, the necessities of his daily life—dozens of medicines, supportive cushions, tools to jerry-rig or make ergonomic adjustments—are mixed in with hundreds of acrylic paint tubes, canvases, rags, and brushes. His dog, a Chihuahua-mutt mix, navigates the cluttered terrain.

Logan's painting "Born This Way" (see page 6) defines his "Syndrome Psychology" series, which Logan has been working on for more than 10 years and has had exhibited a number of times. The series captures the characteristics of Logan's body and his emotional mindset. In "Helpless," he lies prone, ribs exposed, clutching the back of his head. In "Love What Makes You Different," Logan's right eye—an eye that has undergone five surgeries—stares out at the viewer through a heart-shaped tunnel he makes with his hands. Logan has endured 24 surgeries in his life, so far.

"People stare, so I wanted to make paintings so people could stare all they want," says Logan. "Call it an offensive stance." Before this series, Logan was known for his robust, close-up paintings of individual flowers—a viewer so close might be tempted to sniff for a floral scent. "At my core, I'm colorful, bold, and powerful. That is why I gravitated toward flowers," says Logan. "I'm also a hopeless romantic."

When Rarity Strikes Twice

"I didn't think they would live through childhood," says Debbie. When Heather was born in 1977, it was immediately obvious something was wrong. Her arms were exceptionally short and her wrists were bent at a 90-degree angle. Initially, physicians thought she had Treacher Collins syndrome because of her facial characteristics (underdeveloped cheekbones, abnormally small jaw, cleft palate, cup-shaped

ears, drooping lower eyelids). When Heather was 18 months old, a geneticist determined that it was Miller syndrome (then known as postaxial acrofacial dysostosis). There were only three other documented cases in the world at the time.

When considering whether to have a second child, Debbie and her husband Terry (since divorced) were assured by a geneticist that the chance of having another child with Miller syndrome was one in a million—and probably even lower than that because it had already happened. Just to be sure—and to prepare herself—Debbie had an ultrasound in the seventh month of her pregnancy. "You're going to have a healthy baby girl," she was told.

On April 1, 1980, the doctors delivered an 8-pound, 6-ounce baby boy with the same short arms and bent wrists that Heather had at birth. "It was shocking in a different way than when Heather was born. It was almost surreal," recalls Debbie. Not long after, her pediatrician slapped her on the leg and said, "Congratulations, you just made medical history." No other family existed that included two siblings with Miller syndrome. This was the case until 1988, when another family in New Zealand had a second child born with Miller syndrome.

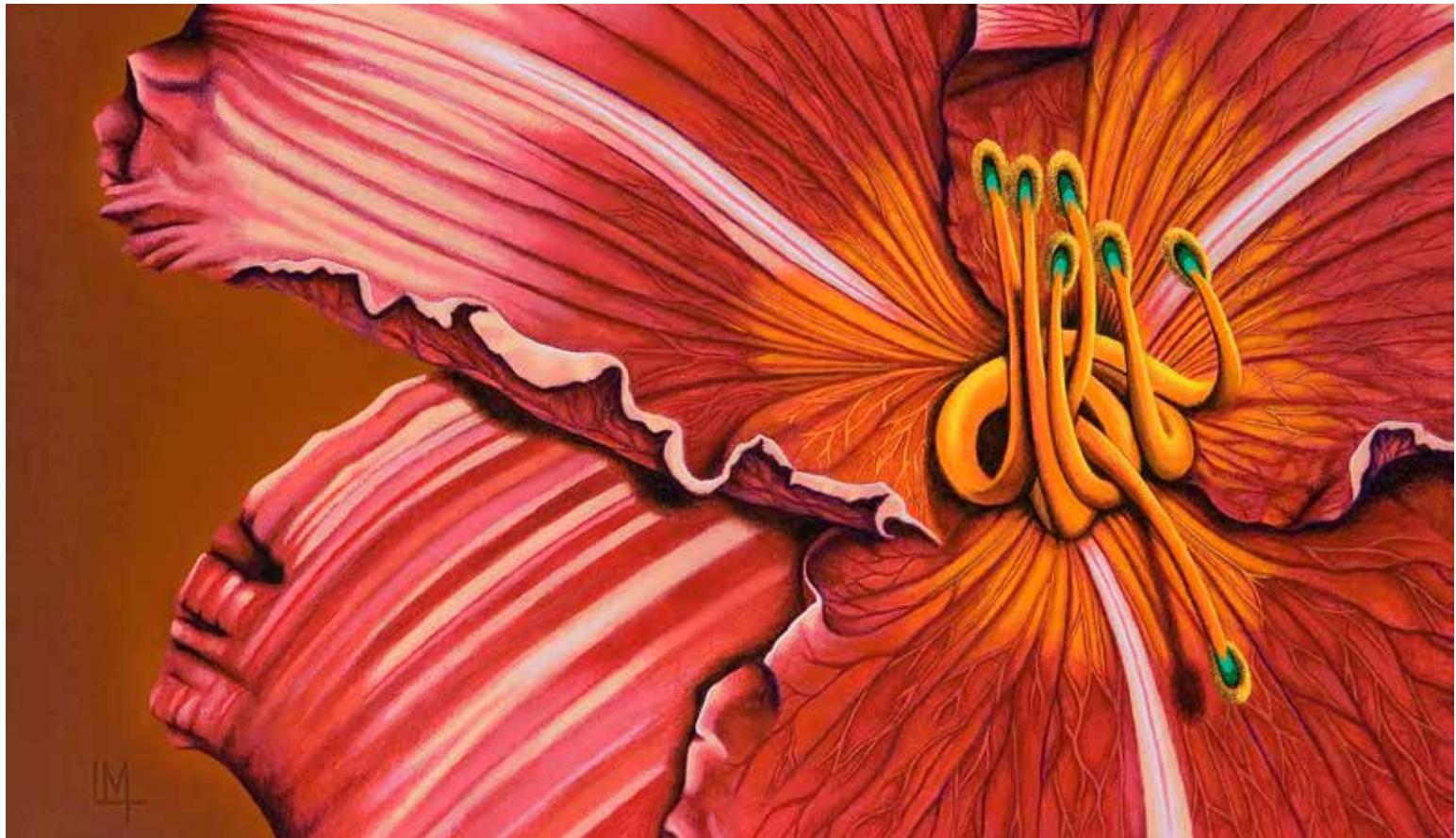
From that point on, every second of Debbie's life would be devoted to caring for Heather and Logan, her only children. Her marriage to Terry buckled, then broke. The children's care required feeding tubes, constant doctors' visits, surprise hospitalizations, and repeated surgeries. Medical bills piled up.

Debbie's story of caring for two children diagnosed with rare diseases is remarkable in its own right and is documented in a film about Logan ("Logan's Syndrome") and in a book



"I already have the intellectual stimulation, which I provide myself. What I need is a friend who can provide the emotional connection that reminds me I am human and compassionate and shows me that it is enough to just be me."

*Heather Madsen, excerpt from *Eight Fingers and Eight Toes: Accepting Life's Challenges**



"Coral Lily" by Logan Madsen

"I believe everybody could be classified in the DSM-5*... We're all struggling with something, because we're all human."

Logan Madsen

she wrote with her daughter Heather (*Eight Fingers and Eight Toes: Accepting Life's Challenges*). Exhausted, worried, and overwhelmed as a single mother, Debbie eventually learned to take one day at a time, one challenge at a time. "When you start looking into the future and worrying about what might happen, you will find yourself quickly depressed."

"I knew that if I couldn't find happiness, how could they?" says Debbie.

For years, she grappled and soul-searched for a way to accept her life—a far different life than she had imagined for herself. Slowly she came to a place of peace and acceptance. "When you are not worried about the future or dwelling on the past, you have more space to find and feel what is good in life, and focusing on this space is what became important to me."

To Logan, explaining what it is like to live with a rare condition and the chronic pain that comes with it is like trying to explain what raising children is like to a childless person. "It is a part of every single moment of your life. You can't help but hope each next moment will be better than the last."

Logan has had to find his own way through his challenges and emotions, which inevitably find their way into his paintings. He says, "I live—and keep wanting to live—by magnifying all the little granules in life on a daily basis so they overwhelm and dwarf the hard parts."

This approach to life is not unlike Logan's approach to the flowers he paints. His canvases, filled with the deep colors and textures of petals and pollen and delicate stamens, vastly magnify those minute details, giving viewers an opportunity to forget their own difficulties for a moment. ■

*DSM-5 is the Diagnostic and Statistical Manual of Mental Disorders



A rare disease is a condition that affects fewer than

200,000 people

There are
7,000
known rare diseases



30 million

Americans have been diagnosed with a rare disease



50%

of people affected by rare diseases are children



One-third

of children diagnosed with a rare disease will not live to 5

Only 5%

of rare diseases have treatments



ARUP has been testing for rare genetic diseases for over

20 years

A Rare Niche: Testing for Hard-to-Diagnose Disorders

Rare is relative.

An estimated 30 million Americans have been diagnosed with one of 7,000 known rare diseases, according to the National Institutes of Health (NIH). So while each disease may be rare, the total number of people living with a rare disease is large. Half are children.

Before a diagnosis, patients and their families face frustration as they search for answers from specialists, scientists, and the internet. Diagnosis can be elusive and the exact causes of many rare diseases are still unknown. "It's difficult feeling so alone, so unGoogleable," Cristina Might said. Doctors eventually diagnosed her son with a disorder stemming from a mutation in the *NGLY1* gene.

While advances in genetic testing have allowed for more diagnoses of rare conditions, only about 5 percent of these conditions have treatments, according to the website, From Hope to Cures, spearheaded by the Pharmaceutical Research and Manufacturers of America (PhRMA).

Evolution in the Laboratory

ARUP Laboratories is at the forefront of testing for rare and difficult-to-identify diseases. "It's our expertise and what we are known for, especially for syndromes that are one in a million," says Hunter Best, PhD, medical director, Molecular Genetics and Genomics and an associate professor of pathology at the University of Utah (U of U) Health.

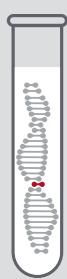
The development of new testing and related technologies, bolstered by

ARUP's academic medical affiliation and its Institute for Clinical and Experimental Pathology®, is allowing ARUP to expand its menu of tests for rare or difficult-to-diagnose diseases. Currently, ARUP offers more than 3,000 laboratory tests, hundreds of which help diagnose rare genetic disorders, for example, retinitis pigmentosa or Charcot-Marie-Tooth disease.

Whole genome and whole exome testing were watershed breakthroughs for genetic testing. Whole genome testing refers to massively parallel sequencing of the entire three billion plus base pairs of the human genome, while whole exome testing specifically looks at the approximately three million base pairs located in protein-coding regions. Both of these methods, using next generation sequencing technology, are actively being used in the clinical laboratory to identify disease-causing variants or changes.

"Theoretically, we could test for any genetic disorder that has ever been described," says Best. "For rare diseases, the challenge from a lab perspective is finding enough patients who have already tested positive for the syndrome to validate testing."

"It's extraordinary what we can test for now," says Elaine Lyon, PhD, medical director, Molecular Genetics and Genomics, who has been involved in ARUP's rapid growth in genetic testing over the past 20 years. "We went from having only two molecular tests for inherited diseases when I started in 1997, to having exome testing and gene panels, with leading-edge technologies needed to keep up with what's possible."



"So many of our rare disease tests are not high volume, but they are very important tests," adds Lyon, who is also a professor of pathology at U of U Health. "Those patients still need an accurate diagnosis, and that diagnosis is extremely meaningful for that family, because in genetic testing, the results affect the whole family, not just the individual." For family members, knowing they are carriers of a genetic disease can influence family-planning decisions.

Rare for Some, Not for Others

Most rare diseases are caused by genetic variants, although other factors can cause disease, too, says Rong Mao, MD, section chief of ARUP's Molecular Genetics and Genomics. "Many times we don't know what triggers it, which is the case with some rare autoimmune diseases. Sometimes doctors are left guessing."

Rare pathogens can cause infections that affect just one or two people. It's not until the infection spreads, as it did with the Zika virus, that it becomes easier to determine what is causing it.

Some genetic diseases are rare except among certain ethnicities—for example, sickle cell disease is more prevalent in African populations, and Tay-Sachs disease has a higher incidence in the Ashkenazi Jewish population.

"Ashkenazi Jewish people tend to marry within their own population, so the mutations tend to accumulate, increasing the likelihood of the disease being passed on to the next generation," explains Mao, who is also a professor of pathology and co-director of the Clinical Molecular Genetics Program at U of U Health. ARUP's Ashkenazi Jewish carrier-screening test screens for 16 conditions.

"In medicine, these 'rare diseases' are the hardest disorders to diagnose, usually sending patients on a diagnostic odyssey, sometimes for years," acknowledges Best. "With our testing, we can help in the patient-care process by confirming the diagnosis and putting an end to that odyssey." ■



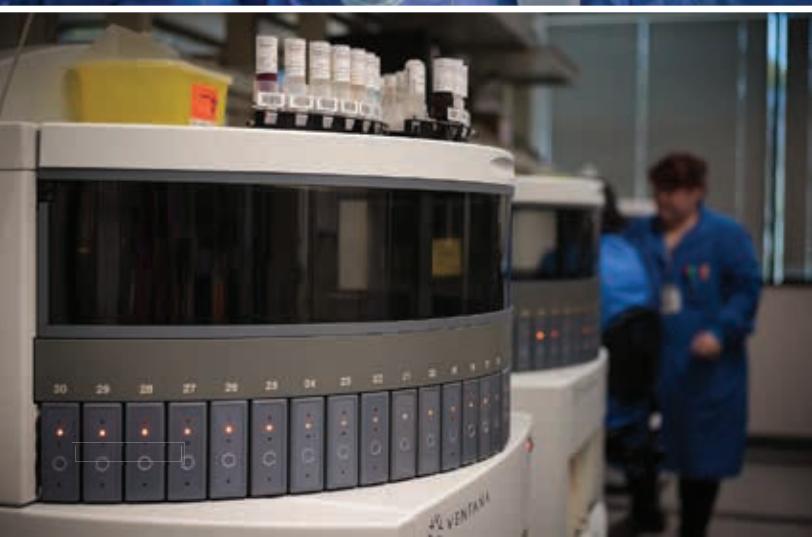
"In medicine, these 'rare diseases' are the hardest disorders to diagnose, usually sending patients on a diagnostic odyssey, sometimes for years. With our testing, we can help in the patient-care process by confirming the diagnosis and putting an end to that odyssey."

Orphan Diseases

In 1983, the Orphan Drug Act defined a rare disease as a condition that affects fewer than 200,000 people. Its passage was an attempt to create financial incentives to motivate pharmaceutical companies to develop drugs for rare diseases, also known as "orphan diseases." Previously, companies had not been interested in investing and developing treatments for conditions that affected so few people. Since the act was passed, the FDA has approved more than 500 orphan drugs.

The National Institutes of Health estimates that 50 percent of people affected by rare diseases are children—a third of whom will not live to celebrate their fifth birthday. An estimated one in three of the nearly 3,000 drugs with orphan designation are for children.

Hunter Best, PhD, Medical Director, Molecular Genetics and Genomics



65-Plus Labs, But What Happens Inside?

The more than 65 individual labs at ARUP Laboratories form a hive of variety. The labs are also highly centralized, resulting in quick turnaround times and efficient tracking, says Martha Bale, vice president, director of technical operations, ARUP. "Because everything is right here, we can send specimens between laboratories very quickly, not take a day to send them elsewhere. Tracking is faster, dramatically cutting the chance of misplaced specimens."

Many labs perform automated tests with amazing machinery, shuttling specimen tubes around tracks to ensure efficient processing. Is it expert engineering, Roald Dahl fiction, or both? (Fortunately, no one's turned into a blueberry—yet.)

In some ARUP labs, there's bustle and, more often than not, an automated result. In others, technologists work individually, carefully staining tissue or arranging paired chromosomes for examination, collaborating when needed to problem solve.

Despite these differences, lab technologists and managers have one thing in common: They notice. Technologists troubleshoot or look for patterns in the case of any unsuccessful result. Those who excel in their work have an eye for discerning irregularities and solving puzzles.

Want to take a look inside labs without donning white coats and protective gloves? Let's get a glimpse into five of them here.



Automated Core/Automated Endocrinology Labs

State-of-the-art instruments are used to run about 180 categories of tests in these two labs. One of the primary tests in the Automated Core Lab is maternal serum testing, which looks for specific markers in amniotic fluid or serum/plasma from expectant mothers.

With tasks that vary from preparing test runs to analyzing data, a spectrum of specialists performs the work in both labs, says Ryan Greer, assistant vice president and group manager of Technical Operations, Chemistry.

The two labs' high volume of tests makes them ideal places for technologists or technicians, some of whom have high school diplomas and are working on their medical laboratory science (MLS) degrees, to gain broad experience in traditional chemistry and laboratory work. Others have a place there, too. Technologists with MLS degrees can perform tests, and scientists with advanced degrees perform data analysis, says Greer.

Automation's objective, he says, is to take testing that traditionally relied on a medical scientist to interpret and make judgments and standardize the analytic process to achieve consistency. Test result accuracy is typically higher with automation, and smaller staffs can run large volumes on a 24/7 schedule, says Greer.

Brainpower still has a place in automated labs, though. "I'd like to debunk a myth that in automated labs, you just put samples in, push 'go,' and walk away," notes Greer. Being able to load the analyzer and walk away frees staffers for other tasks, such as scrutinizing the data, he says.

Technicians and technologists who excel "have an eye for detail, the ability to think critically, and can find subtle patterns and nuances in huge amounts of data—all of which makes them very successful at catching and understanding problems in data," says Greer. ■



"A spectrum of specialists performs tasks that vary from preparing test runs to analyzing data in the Automated Core and Automated Endocrinology labs."

Ryan Greer, Assistant VP and Group Manager, Technical Operations, Chemistry



Brandon Chandler, Cytogenetics, and Karen Delgado, Genomic Microarray, often troubleshoot cases in their shared office space.

Richard Fedderson evaluates paired chromosomes for aberrations.



Cytogenetics Lab

Cytogeneticists have a big job looking at small details.

At ARUP, the Cytogenetics Lab performs two types of analysis: chromosome and fluorescence in situ hybridization (FISH). Using FISH, technologists prepare short sequences of single-stranded DNA called probes to match an area of the gene for which the researcher is looking. Fluorescent dye colors are attached to the probes to differentiate them. Researchers then compare the probes with the dual-stranded actual DNA to find differences. They can perform comparisons on nondividing cells that are between phases.

A chromosome analysis involves meticulously scrutinizing chromosomes from patient samples for gains, losses, or rearrangements of genetic material.

Through training and experience, technologists performing these tests develop a comprehensive understanding of each chromosome's structure and its associated banding pattern. Some abnormalities are easily recognizable, such as a gain of an entire chromosome 21, which results in Down syndrome. Other abnormalities may require a high level of skill and experience to detect. This is especially true for oncology cases, in which only a couple of the 20 cells analyzed per case may be abnormal.

Identifying a low-level, abnormal clone takes serious, close examination. If found, such a detail determines the specific type of cancer present and predicts disease course. It can even help to establish a course of treatment and aid in the monitoring of treatment effectiveness. However, the necessary analytical ability isn't developed overnight. "It typically takes three to five years of repetitive chromosome

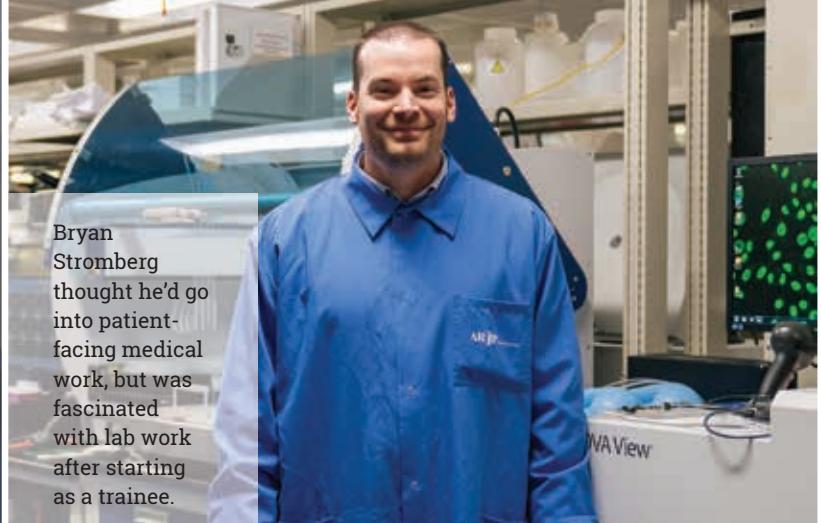
analysis training before a technologist is truly adept at analysis," notes Brandon Chandler, technical supervisor, New York, in Cytogenetics at ARUP.

A few things happen before all that analysis, though. First, samples go through extensive processing in the wet lab. A technologist puts specimen cells into a wet media in which the cells can actively divide. The ideal result is many dividing (mitotic) cells. After a designated incubation period, cultures are harvested to produce a fixed cell pellet. Transferring the metaphase cells (at a stage of mitosis in which chromosomes are condensed and microscopically visible) from the pellet to slides takes significant skill, says Chandler.

The goal is to get the chromosomes in each metaphase cell to spread as much as possible without rupturing the cell membrane. It's necessary to have a steady hand in dispensing the sample onto the slide, and temperature and humidity must be tightly controlled. The slides are stained, then scanned with a digital microscope system.

At that point—ta-da!—it's time for analysis. Special software similar to that used for photo editing helps align chromosome pairs. Then they are ready to be evaluated carefully for aberrations. A straightforward case can be analyzed by an experienced technologist in less than an hour; however, a complex, abnormal case can keep an analyzer busy for several hours. Chromosome analysis is both challenging and fun, asserts Chandler, because you never know which type of abnormality you will encounter. Each cell is a unique puzzle waiting to be solved.

All that careful scrutiny can have a very cool conclusion, says Chandler. "If you do find that needle in the haystack in an oncology case, you're helping to identify the specific abnormality that a patient has, and you're helping a physician to zero in on the proper treatment. It's rewarding to know that your efforts have a direct impact on someone's life." ■



Bryan Stromberg thought he'd go into patient-facing medical work, but was fascinated with lab work after starting as a trainee.

Microbial Immunology I Lab



After working as a veterinary technician and loving the job's lab work, Kathryn Olson, technical supervisor, talked with a microbiologist who advised her to get into medical technology. "That was the first I'd heard of it."

With a focus on infectious diseases, Microbial Immunology (Micro Imm) I technologists sometimes do work that makes the news.

For example, this lab tested the blood of 457 Olympic athletes returning from the 2016 Summer Games in Rio de Janeiro for a University of Utah study reported last fall. The study's surprising results showed that none of the tested Olympians had contracted the Zika virus.

One of the lab's main tests is for Lyme disease; it also performs herpes tests and—less in the news, but in high demand for screening healthcare staff—tuberculosis tests. All in all, Micro Imm I tests for 19 conditions, performing about 70,000 tests a month.

On a typical day, technologists arrive in the lab and check the schedule to learn which tests they'll be running. Some tests begin with enzyme-linked immunosorbent assay (ELISA) methodology, using a microtiter plate of multiple indentations, or wells. Into each well, an antigen (a toxin or other foreign substance that causes an immune response in the body, especially antibody production) has been placed. The technologist adds the patient specimen to the same well.

In a test for Lyme disease, if Lyme antibodies are present in the specimen in the well, the antibody attaches to the antigen. The technologist rinses the serum and any antibody stays attached. Adding a chemical at this point produces a color reaction; the more antibody present in the specimen, the more intense the color reaction will be.

If the ELISA test is positive and a reflex test has been ordered, the technologist runs an immunoblot test, in which strips of paper with antigens attached are used to confirm whether antibodies are present for bacterial antigens in question.

Working in Micro Imm I equals happiness for Kathryn Olson, technical supervisor in that lab. She chose lab work after finishing a bachelor's degree in medical laboratory science and decided to obtain a master's of science degree as well "because I loved the work so much." ■

Parasitology and Fecal Testing (PAFT) Lab



Parasites found in the lab, including a long, spiral variety found in raw fish.



Kristin Case and Madison Sant enjoy the daily mystery-solving aspects of their work in Parasitology and Fecal Testing.

In PAFT, the goal is—you guessed it—to find out if a clinging monster (that is, a parasite) lurks within. If one is found and identified, the illness it causes can be treated more effectively. Parasites can potentially infect almost any part of the human body, inhabiting fluids, tissue, etc. “That makes it always different for our lab. We get specimens from the eye, the blood; things that attach to skin, like ticks, or from the intestinal system, like tapeworms,” says Kristin Case, technical supervisor, PAFT.

The lab tests a range of matter: stool, skin scrapings, eye swabs. “We’re not just blood work in Parasitology,” Case notes. Hundreds of specimens are tested in batches each day.

Technologists rotate through several benches in PAFT every day. They analyze parasites using microscopes, and use testing kits and advanced instruments to analyze fungal elements and viruses. If someone is having trouble identifying an organism, the team works together to identify it. “Some are more experienced at identifying parasites and organisms than others, so we learn from each other every day,” says Case.

Tests performed in Parasitology include the following:

- Fungal antigen testing. This uses a methodology called enzyme-linked immunosorbent assay (ELISA). Technologists receive kits from manufacturers, then pipette a small amount of patient specimen into a small tube or well and add certain reagents. There may be a reaction if the antigen from the tested fungus is present.
- Fecal chemistry. Several tests are performed to analyze stool. For example, a technologist can look for fat in stool. If present, fat can be a sign that a person’s gastrointestinal tract is not absorbing fats or other nutrients properly.
- Ova and parasite examination. Technologists read stained slides using a microscope, looking for eggs, cysts, or other signs of parasites.

PAFT is absorbing to technologists day after day, says Madison Sant, senior medical technologist in that lab. “It’s an intriguing medical field, analyzing a patient’s specimen. You’re figuring out the mystery of what’s wrong with the patient. Even though we’re not the doctor or nurse in the room with the patient, we’re able to help the patient by identifying what’s wrong.” ■

Her parasitology training and ARUP’s connection with the University of Utah meant Kristin Case, technical supervisor, was able to train medical workers in China and Africa to be better parasitologists—while she helped collect data for the U of U.

University Hospital Lab



Jo D Fontenot, VP of technical operations, explains that some 75 phlebotomists are involved in meeting patient needs at the U of U and Huntsman Cancer Hospital.



For the University of Utah Hospital, the Mountain West's only academic medical center, this laboratory processes "nearly anything and everything that a hospital needs," says Daniel Savage, technical supervisor of University Specimen Processing at ARUP, noting that most physicians' diagnoses result from lab work. He isn't joking; about 55,000 tests are performed monthly in the lab.

Samples come in with a need for speed from the Emergency Department, Intensive Care Unit, and other high-intensity areas. A test called Complete Blood Count with Platelet Count and Automated Differential (CBCAD) looks for hemoglobin, hematocrit, platelets, and white cell count differential. It's "a quick look inside a patient's blood. It quickly lets a physician know how to treat the patient," says Savage.

Other specialty areas include:

- Therapeutic drug tests, which determine whether a patient taking a medication may need an increase or decrease in dosage
- Coagulation (coag) testing, which monitors therapy with anticoagulating drugs like heparin so that doses can be adjusted accordingly
- Testing of body fluids, such as cerebrospinal fluid (CSF) found in the brain or spinal cord, or pleural (lung) fluid cell counts, to determine white blood cell abnormalities for Huntsman Cancer Institute and University Hospital
- Flow cytometry tests for specific biomarkers and proteins on abnormal cells. This helps identify which complication or disorder the patient is dealing with and the direction for treatment.

The busy, intense world of a hospital lab is an exciting place to make a difference, says Savage. "The test numbers show how important lab testing is. It is how we can look inside a person's body and figure out what's going on, so it is absolutely vital." ■

"Everything in the hospital gets funneled to us—the lab. Doctors can't treat or do anything until they get results back and learn what to do next."

Daniel Savage, Technical Supervisor, University Specimen Processing



Breaking Ground—Expanding Expertise in Diagnostic Medicine



ARUP Laboratories is growing to meet the needs of diagnostic medicine, an increasingly sophisticated science. Building on a pioneering past rooted in academic medicine and three decades of dedication and determination, ARUP will break ground this fall, adding 200,000 square feet of laboratory space. Natural light and mountain views will be plentiful through more than 18,500 square feet of windows.

"Take care of your employees and they'll take care of the business." This mantra has helped ARUP Laboratories grow, over the last 30 years, from a small cadre of brave and dedicated employees to some 4,000 today. Our business? Helping patients. Our 3,000+ diagnostic tests provide answers. And we are busy; some 55,000 specimens from across the country arrive daily.

NATURAL HISTORY MUSEUM OF UTAH

RED BUTTE GARDENS



Shoreline Trail



"Before my shift starts at 11 a.m., I'll take a run along the Shoreline Trail and then shower at work. It really energizes me for my day."

Liz Chandler, Lab Client Support Tech

The View Café

Aptly named for the view from its deck, employees can nosh on a wide selection of meals—prepared fresh each day with plenty of healthy options—or grab a Starbucks drink and a locally-baked pastry to go.



"My boss is really accommodating, so I can go to school and work. My classes are only 5 minutes away, and sometimes I'll take the shuttle. The proximity saves me time and money."

Kenzee Besler, Workflow Coordinator

"I'm a part-time student and can jump on the campus shuttle or walk to my classes at the University of Utah. There's hardly any travel time. Driving, I can be on campus within 5 to 10 minutes."

Jenny Pratley, Lead, Exception Handling

UNIVERSITY OF UTAH



THIS IS THE PLACE HERITAGE PARK



ARUP LABORATORIES



On-Site Day Care



"I can pop in and visit my daughter during the day or stop by and have lunch with her. I love having her nearby at work, and I'm really impressed with the quality of care."

Sydney Stoner, Product Manager

HOGLE ZOO



Wellness Center

Take care of you. To encourage this, ARUP's Wellness Program offers a 4,300 sq. ft. on-site fitness facility, coaches to help you reach your goals, and all sorts of seminars to keep you healthy—mind, body, and soul!



"I meet with a wellness coach once a week who helps me set goals and stick to them. ARUP really wants you to be the best version of yourself that you want to be."

Charles Stohel, Lab Tech, Anatomic Pathology Lab

ARUP LABORATORIES



Family Health Clinic

Literally, walk to your doctor's appointment. ARUP's on-site Family Health Clinic is free to employees and their families. This full-scale clinic specializes in a spectrum of care and can refer you to a specialist when needed. Mental health providers are available too.



Combining Clinical and Financial Intelligence

New EMR Tool Empowers Clinicians to Be Good Stewards

Mukul Mehra, MD, was on a 20-hour flight returning from Bali when he started jotting down numbers. He had been thinking about a patient who had come to him recently with Crohn's disease. In the past three years, the woman had received 18 CT scans of her chest and abdominal area. Mehra calculated her radiation exposure and how it translated to cancer risk: It was the same as if she had been standing one mile from where the atomic bomb landed in Hiroshima during World War II.

Mehra considered other cases involving good physicians with good intentions that went awry because they lacked sufficient testing information, such as costs and the risks of repeat testing. "It is only when we translate it into human terms that people really begin to understand the impact," says Mehra, a gastroenterologist.

By the time he stepped off his flight in Birmingham, Ala., Mehra was determined to find a way to get this vital information to physicians. He knew technology could make that possible. "We needed a way to show physicians the financial cost of what they are doing [in a way that is both] sequential and aggregated, and then put it in human terms for patients—the human cost and the financial costs," Mehra says.

A year later the company Mehra cofounded, IllumiCare, introduced the first prototype of the Smart Ribbon®. Further refinement resulted in an interactive tool now available to hospitals and health systems nationwide.

A True-Picture Cost

For the past year, ARUP Laboratories and IllumiCare have collaborated to improve the Smart Ribbon, especially with regard to laboratory testing. The ribbon hovers over or is embedded in the electronic medical record (EMR) system to provide real-time information about the cumulative risk and financial impact of tests and medications ordered for a patient. Each ribbon is customized to the healthcare organization's preferences. A hospital can pick and choose which features it wants on its ribbon, not unlike how a user chooses apps on an iPhone.

To avoid the nuisance of pop-up alerts, the Smart Ribbon disappears within seconds if clinicians choose not to interact with it. If they do engage with the information the Smart Ribbon offers, they can often use it to improve patient care by ordering fewer and less expensive tests and medications.

"The goal is to provide clinicians with a true-picture cost, allowing them to be better stewards of hospital resources," says David Stricklin, IllumiCare's executive vice president. "We're presenting them with information that doesn't exist in the EMR and helps them be more efficient in how they go about treating their patients, in both care and cost."



"We needed a way to show physicians the financial cost of what they are doing [in a way that is both] sequential and aggregated, and then put it in human terms for patients—the human cost and the financial costs."

Mukul Mehra, MD

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Stricklin points out that existing clients report an average decrease in cost per discharge in medications (12 percent), lab tests (12 percent), and radiology tests (7 percent). IllumiCare uses a financial model built around diagnosis-related groups to calculate cost savings.

What Does This Partnership Mean for ARUP Clients and Others?

Through its partnership with IllumiCare, ARUP has made ARUP Consult, the company's rich source of test selection and interpretation information that covers nearly 300 disease-related topics, available to all Smart Ribbon clients. "This tool helps clinicians choose the appropriate tests to order and serves as a knowledge resource for suspected diseases," Stricklin says.

ARUP is also able to offer its own clients a version of the Smart Ribbon with additional features they can use to improve test utilization. The ARUP Smart Ribbon includes turnaround time (TAT) information for tests and clearly identifies which tests are reference or sendout tests. Armed with those facts, a clinician planning to discharge a patient in two days might think twice about ordering a test with a TAT of four days—rethinking whether the test is necessary or suggesting it be performed after discharge.

The ARUP Smart Ribbon also displays recommended retest intervals to help educate clinicians about whether a repeat test is appropriate during an inpatient stay. When a clinician orders a repeat test, the Smart Ribbon displays information about the initial test, along with a recommendation for when it should be repeated. Exceptions to the recommendation are also noted.

Cutting back on unnecessary tests can improve the patient experience and reduce the risk of anemia. Nobody likes to be repeatedly poked with a needle, and too many blood draws can lead to anemia or even a blood transfusion. A unique feature of the Smart Ribbon for all users is that it informs clinicians of the patient's anemia risk based on blood loss associated with previously performed tests. This summer, IllumiCare will add a feature that tracks narcotic prescriptions and use.

"This is an understated way to educate clinicians on an ongoing basis without taking up their valuable time," points out Andrew Fletcher, MD, director of Consultative Services at ARUP. "In addition, the long-term benefits are significant—cost avoidance, improved quality of care, and patient safety. These factors play a key role in determining whether a hospital will be successful." ■



To see how it works, watch this short video:
www.illumicare.com/arup

What's the Big Deal?

The ARUP Smart Ribbon

- Suggests alternatives to higher-priced drugs
- Recommends when a test should be repeated, so a second test is not ordered earlier—or later—than necessary
- Shows the spend of each provider relative to peers
- Shows test turnaround times
- Shows whether a test is performed in-house or is a reference test
- Shows patient's risk of developing anemia
- Clues in administrators about possible opportunities for improvement

Adding up the Dollars in Day-to-Day Laboratory (Mis)Utilization

While downstream cost savings achieved through improved lab test utilization paint a dramatic picture of the benefits of a laboratory stewardship program, savings directly attributed to the lab from better daily testing decisions should not be underestimated.

"The lab may account for only a small percentage of overall health system expenses, but savings can still be significant," says Ben Chacon, ARUP senior healthcare consultant, whose team works with nearly 100 healthcare organizations a year.

Sometimes, the simplest solutions can have surprising impact. ARUP's work with hospitals to refine their laboratory formularies is an example. While hospitals and physicians are familiar with pharmacy formularies, laboratory formularies are less common. A formulary helps guide physicians by narrowing the test choices down to those that will be most helpful in treating their patients.

Formularies are based on medical evidence and incorporate cost considerations with the aim of improving quality of care. Without a formulary, clinicians can order any test at any time, and they are unaware which tests are performed in-house and which are sent to a reference lab.

Lab formularies promote transparency by noting whether a test is a reference test, and by providing cost and turnaround time (TAT) information to help physicians make better-educated decisions.

Instead of just listing a test by name, such as "homocysteine," for example, the test could be listed as "homocysteine (REF, \$\$, 5d)," to indicate referral status, cost, and TAT. If a patient is soon to be discharged, a physician may only order a test if the TAT information indicates results will be returned before the patient goes home.

Further refinement can involve eliminating outdated tests and providing information to reduce duplicate test orders. Tests can be renamed for clarity. Folate testing, for example, can be listed as "serum folate (screening)" and "RBC folate (not for screening)" to avoid misorders.

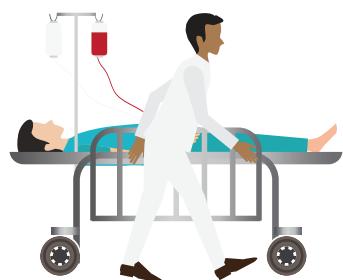
More commonly ordered tests also can be listed higher on the menu with additional information in parentheses to help prevent confusion. Vitamin D tests, for instance, can be listed as, "VIT D 1-25 (nephrology only)," and "VIT D 25 (screening test)." The screening test would be first on the menu because clinicians most often look for and order it.



22%
of meds
unnecessary



25%
of lab and radiology
tests unnecessary



11%
of procedures
unnecessary

"Overtreatment in the United States,"
PLoS One journal

Regular review of order sets (a collection of pre-established tests) can further identify unnecessary or inappropriate test use.

ARUP worked with Western Maryland Health System to establish its test utilization initiative. "We had easy access to a team that included physicians, healthcare consultants, and data analysts," says Kim Smith, laboratory business manager at Western Maryland. "They helped us identify and reduce improper utilization, and then actively participated in implementing changes here."

At Western Maryland, ARUP recognized an opportunity to save money by eliminating most of the point-of-care (POC) tests in the ER. Instead, the hospital system began sending these tests to its hospital lab. The POC test kits each cost \$8 to \$16, while it cost only \$2 to run the tests in the on-site lab.

In addition, "a lot of doctors were habitually reordering the test through the lab because they questioned the accuracy of the POC test," says Sandy Richman, ARUP director of Consultative Services. The change led to an estimated savings of \$207,000 for Western Maryland for the 2018 fiscal year.

"We were very surprised that most changes were easily accepted by the providers," says Smith, noting that medical staff, including emergency, inpatient providers, and specialists, participated in meetings or discussions at some point. "Their willingness to participate and support our initiatives played a huge role in our successes."

Preventing Unnecessary Testing

To prevent unneeded testing, the University of Minnesota Medical Center, Fairview, implemented a "hard stop" in its

"The laboratory drives the results of everything else in healthcare. Fix your lab, and you can cut down on [a patient's] length of stay in the hospital, as well as cut pharmacy and radiology costs."

Andrew Fletcher, MD, Medical Director,
Consultative Services





"We show our clients how to take action based on the data."

Sandy Richman, Director, Consultative Service

test ordering system that alerts physicians if a test they attempt to order has been ordered in the past 24 hours. They must contact the lab for approval to reorder the test.

Fairview also now requires preauthorization by a genetic counselor for genetic tests to determine whether the test can be performed in-house, whether it is a duplicate order, and whether the patient is in an inpatient or outpatient setting.

"We worked with our medical executive committee to develop a policy that strongly discourages inpatient genetic testing," says Fairview Genetic Counselor Matt Bower, who points out reimbursement is often limited when tests are performed in an inpatient setting.

Bower explains that genetic test results are typically returned within four to six weeks, and at that point, the patient may be in someone else's care, outside the hospital. Critical genetic results can "fall through the cracks" if it is unclear whose responsibility it is to follow up. "Sometimes these tests are ordered and the next day, the patient is discharged."

"The testing analysis provided by ARUP has helped us identify over \$1 million in potential savings," says Jo Norton, laboratory director at Fairview. "In this partnership, we are able to take advantage of ARUP's internal expertise on utilization management."

Partnerships to Make Data Actionable

Hospitals generate a plethora of patient data and for most, deciphering and making use of it is a herculean task. "Increasingly, hospitals are being told to make more of their big data," says Chacon. "And they are asking, 'How?'" Lab administrators and medical directors want to know how to use lab data to influence decision makers while continuously improving patient care and the patient experience.

"We show our clients how to take action based on the data," says Richman. Internal innovation and collaboration with other companies allows ARUP to provide clients with the tools to identify and then "fix" gaps in care and save costs. Analyzed data also empowers the messenger (i.e., lab director, lead pathologist, a committee) to make its case to the powers-that-be to put change in motion.

ARUP recommends clients first form a governance committee that includes a variety of executive and medical leaders to help define opportunities, prioritize interventions, implement solutions, and ultimately, gain institutional buy-in.

"Once ARUP scrubbed our data and showed us high-level opportunities, they guided us in forming a committee and pointed out the key players we needed on it," recalls pathologist Christie Elliott, MD, laboratory medical director



at Renown Health in Reno. "They also showed us where test management solutions have worked well for other hospitals."

Renown's Lab Stewardship Committee reviews and approves new tests and technologies, and reviews older tests and technologies to make sure they are still the best options—some may have become obsolete. It also reviews whether more appropriate testing is needed for screening purposes before expensive therapies are used.

"As a committee, we discuss the pros and cons, and sometimes the benefits outweigh the costs," says Elliott, referring to a new in-house heparin-induced thrombocytopenia (HIT) antibody test that could help prevent the need for a new multiplex polymerase chain reaction (PCR) analyzer for respiratory virus panel testing. The new test also may help prevent unnecessary prescriptions for an expensive medication.

"These committees are established to address a variety of clinical misapplications. In many cases, they are working on complex solutions for problems with systemic roots," says Joe Miles, another ARUP senior healthcare consultant.

In today's healthcare environment, the terrain can suddenly morph as repercussions from new policies or regulations play out. Healthcare organizations need to adjust quickly to these shifts. Knowing how the laboratory can help with or hinder financial goals while maintaining or improving patient care is an essential and smart business approach.

"The mind-set we bring to it is: How can we partner with providers and administrators best in order to give them actionable information and guidance on their lab utilization efforts?" says Chacon. "The overriding goal is always what's best for the patient." ■

"Once ARUP scrubbed our data and showed us high-level opportunities, they guided us in forming a committee and pointed out the key players we needed on it. They also showed us where test management solutions have worked well for other hospitals."

Christie Elliott, MD, Laboratory Medical Director, Renown Health

Tracing Downstream Costs Back to the Lab

When hospitals want to cut expenses, the laboratory is often the last place administrators look. After all, lab tests typically account for only 2 to 3 percent of total costs.

Yet Andrew Fletcher, MD, ARUP's medical director of Consultative Services, likes to remind administrators that diagnostic results inform decisions that lead to many other downstream costs that could be avoided with smarter testing.

"The laboratory drives everything else in healthcare," Fletcher says. "Fix your lab, and you can cut down on [a patient's] length of stay in the hospital, as well as radiology and pharmacy costs."

Consider the troponin test, commonly performed in emergency departments on patients complaining of chest pain—one of the most common reasons for emergency room (ER) visits. (Ten million Americans visit ERs annually complaining of chest pain.) Chest pain could indicate a heart attack, so doctors typically repeat a blood test to evaluate changing levels of troponin, the protein the heart releases when damaged. Some hospitals repeat troponin tests every six hours, while others may repeat them every four hours; the American Heart Association and other authorities recommend repeat testing three to six hours after the initial test.

Fletcher helped spearhead a change in his previous role at Mountain States Health Alliance (now Ballad Health) that shaved the time for repeat testing from six hours to three. What happened as a result? Astounded administrators saw a remarkable drop in patients' length of stay because performing the repeat test earlier enabled the health system to release patients whose test results ruled out heart attacks. Patients who would have been admitted ended up not having to spend the night. A 24-hour stint in the hospital typically costs an estimated \$2,000.

Avoiding Downstream Costs via Radiology

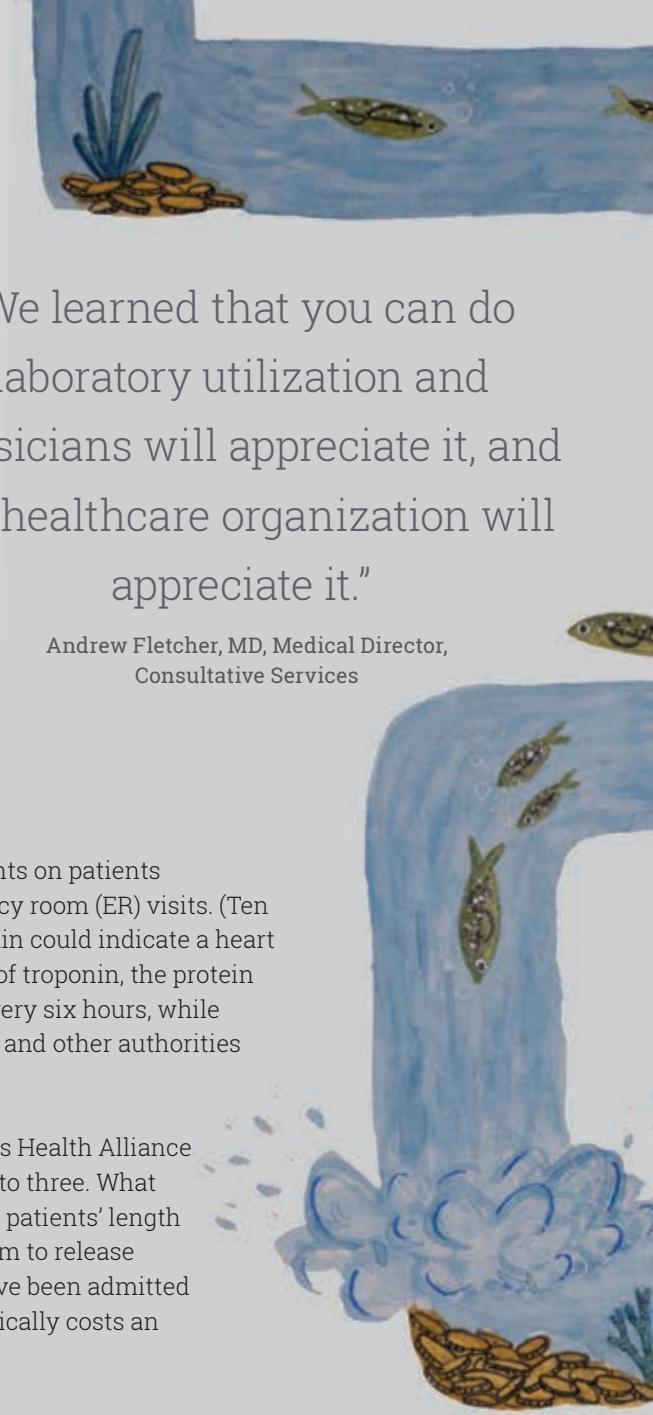
In addition to shortening length of stay, laboratory tests also can influence radiology costs. Consider the D-dimer test, the go-to test for patients suspected of having blood clots in the lungs or elsewhere (referred to as pulmonary embolisms, or as deep vein thrombosis, respectively). Elevated levels of D-dimer protein may indicate a blood clot. If the results indicate elevated levels, physicians order CT scans for their patients.

However, a variety of factors unrelated to a clot can cause high D-dimer levels, which led Choosing Wisely, a campaign headed by the American Board of Internal Medicine, to develop a risk-stratification strategy to help doctors determine whether the D-dimer test is the best choice for a specific patient suspected of having a clot.

Some hospitals have embedded this risk-stratification tool into their test order entry fields to help physicians determine whether a patient is a good candidate for the test. One ARUP client saw CT scan orders drop from 6 percent to 2 percent of patients coming into the ER with suspected blood clots. In addition to reducing radiology costs, this also saved patients unnecessary exposure to radiation. (Exposure from a CT scan is equivalent to that from

"We learned that you can do laboratory utilization and physicians will appreciate it, and the healthcare organization will appreciate it."

Andrew Fletcher, MD, Medical Director,
Consultative Services





One ARUP client saw CT scan orders drop from 6 percent to 2 percent of patients coming into the ER with suspected blood clots.

Lab stewardship efforts at Mountain States helped save \$871,000 in lab and downstream costs.

150 chest X-rays.) For patients who did receive scans, insurance companies were more likely to pay for the scans because the Choosing Wisely tool justified the procedure.

Avoiding Downstream Costs via Pharmacy

Pharmacy costs lead the way among hospital ancillary service expenses, and typically are five to six times more than laboratory costs for a hospital. That's not surprising when you consider that the United States has some of the highest prescription drug prices in the world.

Using lab tests wisely can curtail costs in this area significantly. A healthcare system, for example, can configure its test order entry system to alert physicians to tests available for monitoring the efficacy of therapeutic drugs. It also can build in mandatory monitoring of therapeutic drugs partway through treatment to ensure they are working.

The potential savings becomes obvious when you consider, for example, that a full cycle of a particular drug may run \$100,000. If it is a five-dose cycle, it breaks down to \$20,000 per dose. An associated laboratory test (costing approximately \$1,000) can be used partway through the treatment cycle to determine whether the drug is effective. For example, has the patient built up antibodies to the drug? If the answer is yes, the physician can review other treatment options. This not only saves perhaps \$60,000 in drug expenses, it also ensures that patients are getting the best treatment for them and not wasting vital time.

In its first year, Fletcher's laboratory stewardship effort at Mountain States helped the health system save \$871,000 in lab and downstream costs. He says other health systems can repeat that result by identifying opportunities and implementing better test utilization to cut costs while also improving patient care.

"We learned that you can do laboratory utilization and physicians will appreciate it, and the healthcare organization will appreciate it," says Fletcher. "It is okay for the laboratory to speak up and practice laboratory medicine." ■

ARUP's Utah Promise Scholarship Is Changing Lives

For Diana Martinez, hardship became a motivator. Despite coming from a family that has wrestled with homelessness, domestic abuse, and drug addiction, she is attending college—the first in her family to do so.

Martinez is one of 650 University of Utah (U of U) freshmen who since 2014 have received an ARUP Utah Promise Scholarship, which has given them access to a college education that might otherwise have been out of reach financially.

"I don't want anyone I love to ever have to go through what I did," says Martinez, who is a prelaw student in the Honors College. She plans to break the chain of poverty that has always shackled her family.

While admission to the U of U is in itself an accomplishment, paying for college is an equally significant challenge for those from vulnerable, socioeconomically disadvantaged backgrounds. "Offering students the opportunity to reach their highest educational potential is invaluable," says Mary Parker, associate vice president for enrollment management at the U of U.

The scholarship awards students \$2,000 annually (\$1,000 per semester) and is renewable for up to four semesters. Students are eligible to apply if their family income does not exceed 200 percent of the federal poverty level. The U of U combines the money from Utah Promise with federal and state aid to develop an award package to support the student. The U of U's Office of Scholarship and Financial Aid manages the scholarship.

"Education and helping others is a big part of what drives our culture here at ARUP Laboratories," says CEO Sherrie Perkins, who has been with ARUP for more than 20 years. "It's an absolute honor to help these students, and it's both humbling and inspiring to see the challenges they've overcome."

Utah Promise Scholarship recipient John Eggleston recalls living on the streets with his mother and siblings when he was 10 years old. "We moved into a shelter for abused women and children, and for the next three years, I wondered what direction my life would take," says Eggleston, who is the first in his family to attend college.

He is majoring in international studies and minoring in business, aiming to work with global organizations in the field of economics. "If it wasn't for these types of scholarships, I wouldn't be here. It's like a lifeline for me."

"We are deeply grateful for ARUP's support through the Utah Promise Scholarships to assist many talented students who otherwise would not be able to attend the U," said Ruth V. Watkins, U of U president. "This is a terrific contribution to improving lives and strengthening our university and our community." ■

"We moved into a shelter for abused women and children, and for the next three years, I wondered what direction my life would take."

John Eggleston





ARUP CEO Sherrie Perkins meets with John Eggleston and Diana Martinez, both of whom received the Utah Promise Scholarship to help them pursue a college education. They are the first in their families to attend college.

"I don't want anyone I love to ever have to go through what I did," says Martinez, who is a prelaw student in the Honors College. She plans to break the chain of poverty that has always shackled her family.

People Proud



Tracy I. George



Judy Moore



Joely A. Straseski



Robert Schmidt



Chaz Bollwinkel



Shelby Firouzi



Kamisha Johnson-Davis



Larissa V. Furtado



Carmen Gherasim



Curtis Bell



Natalie Sargent



Holly Gurgele

Tracy I. George, MD, executive director of Clinical Trials and PharmaDx, was elected president-elect for the International Society for Laboratory Hematology in May 2018.

Kamisha Johnson-Davis, MD, medical director of Clinical Toxicology, was awarded an international travel grant to attend the 16th International Association of Therapeutic Drug Monitoring & Clinical Toxicology Congress in Brisbane, Australia.

Judy Moore, medical technologist in the Parasitology and Fecal Testing (PAFT) Laboratory, received the Student of the Year award from the Utah Chapter of the American Society for Clinical Laboratory Sciences in "recognition of outstanding achievement and commitment to the Medical Laboratory Profession."

Larissa V. Furtado, MD, medical director of Molecular Oncology, was nominated as one of the 2018 40 Under Forty honorees by the American Society for Clinical Pathology (ASCP). The award recognizes ASCP members whose work is "making an impact on pathology and laboratory medicine."

A group including medical director **Joely A. Straseski, PhD**, and ARUP fellow **Carmen Gherasim** received the Endocrinology Division Annual Meeting Abstract Award, Mass Spectrometry and Separation Sciences Division Abstract Award for Outstanding Research, and an Honorable Mention: Student Oral Presentation Contest from the AACC for the abstract, *Fulvestrant interference with six automated estradiol immunoassays and an LC-MS/MS method: an analytical and clinical investigation*.

Knowledge fuels the engines here at ARUP, and our dynamic cadre of research scientists provide know-how and expertise. Each year, they publish hundreds of articles in leading journals, present at conferences around the world, and contribute to professional organizations. In this issue we also acknowledge ARUP employees from other areas of the company for awards received. We are proud that they are being recognized for their hard work and expertise.



Alisyn Hansen



Pinar Bayrak-Toydemir



Jamie McDonald



Natalia Wilkins-Tyler



Deanna Lemke



Catherine Arnold



Darrin Cottle



Whitney Woorderchak-Donahue



Chance LaSalle



Peta Owens-Liston



Mary Paul

Medical directors

Joely Straseski, PhD, and Robert Schmidt, MD, PhD, received the Distinguished Abstract Award from the AACC Academy for the abstract, *Thyroid-related testing utilization: a multi-center benchmark study*.

The Health and Wellness Department earned the Centers for Disease Control and Prevention's Full Recognition for its type 2 diabetes prevention program. Staff members from the Wellness Center (**Curtis Bell, MS, Chaz Bollwinkel, MHA, Natalie Sargent, Shelby Firouzi, MS**) and the Family Health Clinic (**Holly Gurge, PharmD, BCACP, CDE, Alisyn Hansen, PharmD, BCACP, CDE, Darrin Cottle, PA-C, RD**) worked together to deliver "a quality, evidence-based program that meets all of the standards for CDC recognition" and were commended by the CDC for "turning the tide in the fight against the epidemic of type 2 diabetes."

A group including medical director **Pinar Bayrak-Toydemir, MD, PhD**, R&D principle investigator **Whitney Woorderchak-Donahue, PhD**, and genetic counselor **Jamie McDonald, MS, CGC**, received the Best Scientific Presentation Award at the HHT International Scientific Conference for the abstract, *Identification of new genes and genetic modifiers in HHT that alter clinical severity*.

ARUP's Integrated Marketing Communications (IMC) Department received several awards for creating outstanding digital media. The Journey of a Specimen video series (shot/edited by **Chance LaSalle** with contributions by **Natalia Wilkins-Tyler**) won two gold AVA Digital Awards, one honorable mention, and a Communicator Award.

ARUP's IMC Department received several additional awards. The *Magnify* magazine article, "From Your Sister with Love—The Gift of Life" by **Peta Owens-Liston** won a gold Hermes Creative Award; the *Magnify* magazine Winter 2017 cover (designed by **Deanna Lemke**) received a Hermes Creative Award Honorable Mention; a gold Hermes Creative Award was given for the Utilization Management pages on arulab.com (designed by **Mary Paul**); the blog article "Non-Opioid Pain Management: Searching for Natural Compounds to Replace Opioids (Q&A)" by **Catherine Arnold** received a gold Hermes Creative Award.

Research Grants

ARUP medical directors pose and ponder deep scientific questions. Each year, staff members are awarded single or group grants to conduct research to answer such questions. Because government funding fell below 50 percent of all scientific research funding starting in 2013 (according to figures from the National Science Foundation), and is thought to be lower than that by many scientists, it's especially impressive when a grant is awarded. We are proud that our researchers are being recognized for their ingenuity, expertise, and diligence.



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Rong Mao, PhD



Mark Fisher, PhD



Attila Kumanovics, PhD



Karl Voelkerding, PhD



Elaine Lyon, PhD



Wade Samowitz, PhD

Mark Fisher, PhD.
Characterizing the role of antimicrobial peptide resistance in plague transmission. \$1.9 million from the National Institutes of Health (NIH) for a 5-year grant. Goal: To determine the genetic and molecular mechanisms of resistance to cationic antimicrobial peptides (CAMPs) in *Yersinia pestis* (the bacterial agent of the plague), and the role this resistance plays in allowing it to successfully infect fleas.

Pinar Bayrak-Toydemir, PhD; Attila Kumanovics, PhD; Rong Mao, PhD; Karl Voelkerding, PhD. *Web Tools for Physician-Driven Diagnostic Interpretation of Genomic Patient Data.* \$718,914 to the University of Utah. Goal: To develop highly visual web software tools to enhance the identification of disease-causing genetic variants for physicians and diagnostic pathologists at the point of care. These tools will facilitate rapid, effective, highly visual data quality control, and the rapid interrogation of inherited, potentially disease-causing variants.

Elaine Lyon, PhD; Rong Mao, PhD. *The Clinical Genome Resource – Expert Curation and EHR Integration.* \$3,050,000 to the University of North Carolina at Chapel Hill (ARUP medical directors are taking part in a multi-institutional grant-supported project). Goal: To provide a centralized, publicly accessible repository of information about human genetic variation and its relationship to health and disease. The result will be a resource that facilitates the clinical interpretation of genome-scale sequencing tests.

Wade Samowitz, PhD. *MiRNA and Colorectal Cancer: Associations with Tumor Phenotype and Survival.* \$1,124,223 to the University of Utah. (Samowitz is participating in a larger grant-funded study.) Goal: To learn more about the role of microRNAs (miRNAs) in colorectal cancer. MiRNAs are a class of small regulatory RNAs (biological macromolecules, or large molecules containing many atoms, that are essential to life, along with DNA and proteins) that mediate post-transcriptional silencing of specific target messenger RNAs (mRNAs). The researchers' hypotheses include that miRNA expression is associated with inflammation-related genetic and lifestyle factors that are key to colorectal cancer.

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For past and current issues, visit: www.aruplab.com/magnify



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