ECHO LOCATION

For new ECHO grant, Inova’s researchers scrutinize the interplay of environment and genomics on children’s health.

THIS ISSUE

Zeroing in on the gut microbiome — and its by-products — for key research findings

MediMap VIP 360° helps physicians use DNA to prescribe the right medication

Inova’s investment in genomic big data yields big returns

spring/summer 2017
The Beat Goes On

Treatments improve for heart failure patients; challenges remain

It’s been 30 years since Inova first transplanted a heart. Since then, Inova’s Heart Transplant Program has become one of the largest and most respected centers, treating such dignitaries as former U.S. Vice President Dick Cheney. It is one of the few U.S. Centers for Medicare and Medicaid Services-certified programs in the Washington, DC, region.

The three-year survival rate for heart transplants in the U.S. is 85 percent. At Inova it’s nearly 89 percent. “We are very proud of that,” says Linda Bogar, MD, Surgical Director of the Heart and Lung Transplant Programs at Inova.

Over the years, techniques to extend people’s lives have improved, which is why many of Dr. Bogar’s patients use ventricular assist devices — known as VADs — to pump their blood. Such devices have helped her to save the lives of hundreds of patients. Patients typically rely on VADs for a period of time between six months and three years prior to transplant.

“The actual procedure of doing a heart transplant hasn’t changed much,” Dr. Bogar says. “It’s really about the team approach we take with patient care that has led to the improvements over the years.”

The transplant team now includes dieticians, case management and social workers, physical therapists, cardiologists, infectious disease doctors and other trained staff who meet weekly. This collaboration has been the key to having a successful program. “The actual part of sewing in the heart at the end is the easy part,” Dr. Bogar says. “We find that fun.”

What has changed over time is the organ donor demographics. Despite a national campaign to increase organ donations, there’s still a shortage of hearts that can be used...
for transplants. Only a very small percentage of people who die — those who are brain dead — are eligible to be heart donors. “This is a small pool to draw from,” Dr. Bogar notes, pointing out that donors or next of kin also must provide consent.

From the 1980s through early 2000s, Dr. Bogar says, many of the donors were trauma or stroke victims. However, legislative and medical improvements, such as more widespread use of helmets and seatbelts and stronger trauma care, have reduced the number of motor vehicle and motorcycle accidents, as well as deaths from gun violence and strokes. As a result, Dr. Bogar says, more people are living, which also has reduced the pool of heart donors.

To combat the shortage, Dr. Bogar and others within the transplant community have been working for years on a new policy that was recently approved by United Network for Organ Sharing, a private nonprofit organization that helps with organ procurement. The policy will hopefully allow for organs to be transported across regions to serve the sickest eligible recipients. This would help “level the playing field” and account for degrees of medical urgency not found in the current system, she says.

In the meantime, Dr. Bogar is using mechanical assist devices as both long-term treatment and to help bridge the gap for people who are waiting for transplants.

“A lot of times they can’t wait for that heart to become available; we have to put in a VAD to help pump the blood for them,” she says. “That gets them into better shape before going into a transplant because we can get the extra fluid off of them and they can live their lives at home while they wait.”

Two dignitaries attended events organized by Inova Heart and Vascular Institute. First, Vice President Dick Cheney spoke in late April at an event recognizing the 30th anniversary of the first heart transplant at Inova and celebrating the growth in all facets of heart and vascular treatment. Cheney underwent a heart transplant at Inova five years ago.

Then, in early May, President Bill Clinton addressed the 2017 Inova Cardiovascular Symposium, an audience of more than 500 cardiologists and primary care physicians. He shared his story of how cardiovascular disease shortened the lifespan of several family members, saying, “Next thing you know, I’m one of those people keeping you in business.” He expressed his gratitude for “the 12½ years your profession gave me” and provided details about the humanitarian work and health initiatives he has undertaken during that time.

A Partnership for the Future
Inova collaborates with Shenandoah University on healthcare programs for nurses, others

In April, Inova disclosed that it has expanded its academic partnership with Shenandoah University, a liberal arts university in Winchester, VA, to educate healthcare professionals in the areas of population health, pharmacogenomics and other new healthcare technologies.

As part of the collaboration, the new programs will be headquartered at the Inova Center for Personalized Health (ICPH) in Fairfax. The 28,000 square feet of space devoted to the Shenandoah presence will include administrative, classroom and clinical space. Inova is investing $5 million in the deal.

 “[This] announcement expands Shenandoah University’s medical educational programs and, thereby, increases the number of healthcare professionals available to serve the needs of the Northern Virginia community,” says Mark Stauder, President and COO of Inova.

The partnership builds on Inova’s goal to be a global leader in personalized health. Inova believes that as genetic testing becomes more commonplace, education must include applicable course work and subsequent clinical experience. Specially trained healthcare professionals need to be prepared to advise patients and families, as well as facilitate a patient’s personalized health plan.

“Shenandoah University will be the first university on the ICPH campus and joins a unique, internationally prominent hub for discovery, prevention, health and longevity that will connect researchers, clinicians and empowered consumers — all for the benefit of our community, our patients, our friends and our family members,” says Todd Stottlemyer, CEO of ICPH.

(From left) Shenandoah University’s Vice President for Academic Affairs Adrienne Bloss, PhD, and President Tracy Fitzsimmons with Inova Center for Personalized Health President Todd Stottlemyer, in front of ICPH.

Learn more about educational opportunities at Inova at inova.org/education.
Supporting Life

Heidi Dalton, MD, Director of Adult and Pediatric Extracorporeal Membrane Oxygenation (ECMO), leads her field

Heidi Dalton, MD, a world-renowned specialist in pediatric critical care medicine, knows a thing or two about treating adults. That is why she is overseeing the extracorporeal membrane oxygenation (ECMO) program at Inova. ECMO is a modified form of cardiopulmonary bypass that can support the heart, lungs or both. Dr. Dalton, who began helping to expand the ECMO program at Inova in 2016, talks about the program and her new role.

How exactly does ECMO work?
Blood is drained from a large vein in the body to the ECMO pump, advancing it to the ECMO machine’s membrane lung, which adds oxygen and removes carbon dioxide. The oxygenated blood is then returned to the body. Advances in technology allow ECMO support for weeks or months until organ recovery occurs. It can also be used as a temporary support to allow transition to long-term heart assist devices or transplantation.

How has the target population of ECMO changed?
While ECMO is still used for postoperative cardiac support and in newborn respiratory failure, new equipment that is more efficient, safer and faster to implement has allowed it to expand to older patients with shock, respiratory failure or even as a means of resuscitation during cardiac arrest.

What is your role in ECMO at Inova?
Inova has provided ECMO for postoperative cardiac support in the past, and I am helping Heidi Dalton, MD, Director of Adult and Pediatric Extracorporeal Membrane Oxygenation (ECMO), leads her field

I can’t say there are any “typical” patients anymore.

to expand the program to those ranging from newborns through adults with other conditions. We have established a 24/7 in-house ECMO team for bedside care; we work with our surgical and critical care colleagues and heart-lung machine specialists to help implement ECMO in emergencies; and we have expanded our patient population to those with respiratory failure and shock from many causes. We are also a referral center for the region for ECMO support. With everyone’s help, we have significantly increased the hours of ECMO support this year.

Who is the typical ECMO patient?
I can’t say there are any “typical” patients anymore. We look at patients on a case-by-case basis and try to establish if we (along with the family and the rest of the medical team) think the benefit versus risk is reasonable. Trauma patients; bridge-to-transplant patients; patients with cancer, shock or respiratory failure; and many others may be candidates.
Beacons
HEAR IT FROM AN EXPERT

Healthy People, Healthy Planet

The surprising impact healthcare has on our environment

by Chip Goyette, Sustainability Director for Inova’s Office of Sustainability

Inova is aware that there are by-products of progress. Take advancements in modern healthcare. There is no doubt these advancements have had a profound impact on our quality of life, contributing to the eradication of diseases, illness prevention and, in many cases, saving lives.

Unfortunately, this progress also produces an unintended side effect in the form of significant environmental impacts. In the process of healing patients, hospitals around the world use a vast amount of natural resources, generate significant waste and consume huge amounts of electricity. This translates to increases in greenhouse gas emissions and air-quality issues.

The numbers tell a compelling story. The healthcare sector in the United States emits 8 percent of the nation’s total greenhouse gases while at the same time commands 18 percent of the nation’s gross domestic product. This is important because although we are responsible for greenhouse gas emissions and the resulting impacts, we have substantial leverage to push the market toward a more sustainable future.

We understand here at Inova that ensuring our planet is healthy is tantamount to keeping our patients and communities healthy. In 2016 alone, we honored this commitment by:

- Building our Women’s and Children’s Hospitals to achieve LEED Silver Certification
- Recycling over 1 million pounds of waste
- Reducing our systemwide energy footprint by over 13 percent since our 2012 baseline year
- Diverting 15 hippos worth (many tons) of medical waste from landfills through medical device reprocessing
- Serving sustainable, nutritious meals in our cafeterias
- Consuming less energy, increasing renewable energy use, reducing waste, serving healthier foods and purchasing environmentally preferable products are practical solutions and examples of the ways we improve the health of the world around us. These activities will not only reduce the impact of our operations, they will save money and improve the well-being of our patients and employees.

Healthcare employees know well our moral obligation, First, Do No Harm, and the future of health relies on our leadership. The three-minute film “Do No Harm” calls climate change a medical emergency and explores what it calls “the healthcare sector’s moral mandate to respond,” along with its “power to be a tipping point toward a better future.”

Learn more about ECMO in young people at inovachildrens.org/ecmo. To provide community support for the program, call 703.299.2072 or visit foundation.inova.org.

See the film “Do No Harm” and read more expert opinions at inovanewsroom.org. Learn more about how Inova is leading in the environmental effort at inova.org/sustainability.
POTENTIAL OUTCOMES:
UPPER AND LOWER AIRWAY ISSUES
OBESITY RISK
PRE, PERNAL AND POSTNATAL OUTCOMES
NEURODEVELOPMENT ISSUES
When the Tooth Fairy pays a visit to some of Inova’s smallest patients in coming years, their lost baby teeth won’t only yield spare change for the children’s piggy banks, but also a treasure trove of information that could benefit public health for generations to come.

In the same way the rings of a tree hold clues to the tree’s development, the youngsters’ teeth will be analyzed, layer by layer, to determine what chemicals, hormones and other environmental substances they were exposed to during their mothers’ pregnancies and in their first years of life. The novel testing is part of a massive initiative by the National Institutes of Health (NIH), placing Inova Translational Medicine Institute (ITMI) in an elite handful of institutions studying how lifestyle, environmental and genetic influences converge to affect development, health and future disease risk.

Known as ECHO (Environmental Influences on Child Health Outcomes), the $157 million research program awards Inova $9.5 million over the next seven years. Inova’s primary collaborator and the grant’s lead institution is the Icahn School of Medicine at Mount Sinai Medical Center of New York City, whose laboratories...
can comb through satellite data to pinpoint air quality in any location and “peel” through baby teeth to scrutinize chemical content.

“This puts us into a national program since it’s not just simply a one-time grant,” says John Niederhuber, MD, Chief Executive Officer at ITMI and principal investigator of the ECHO program at Inova. “It’s validating to the vision we had five years ago when we decided that if we really want to understand disease and how it begins, we really need to focus on the first phase of life.”

Desirable Forces
Indeed, the NIH found Inova’s existing patient group of more than 3,200 children and families extremely enticing. Since ITMI’s launch in 2011, Dr. Niederhuber and colleagues have worked strenuously to recruit these families into groundbreaking studies linking genomic and clinical information to personalized approaches to wellness, medication use and disease prevention. As a prerequisite to ECHO inclusion, all seven participating institutions boast existing patient cohorts, an expedient approach enabling the NIH to combine data to answer questions that couldn’t be addressed by each center alone.

Other partners in the ECHO award include Harvard University, Ben-Gurion University, Columbia University, University of North Carolina, Boston Children’s Hospital and Northwestern University. Drawing from all, the NIH aims to enroll more than 50,000 children from diverse racial, geographic and socioeconomic backgrounds.

Amassing a strong group of Inova research participants “is obviously a horse that was well-played,” says Kathi Huddleston, PhD, Director of Clinical Research Projects at ITMI. She also credits Fairfax County for helping endow ITMI research along the way. Fairfax County has provided at least $500,000 each year to ITMI since its inception for study/research support. “There’s going to be a lot of funding and a lot of good science tracking these children. It’s great for Inova to build that next level of sophisticated science.”

Inova’s Spotlight: Neurodevelopment
To investigate how exposure to environmental factors — including maternal behavior from preconception through pregnancy and early childhood — affect health and development into the adolescent years, Inova and other ECHO centers will analyze exposure to air pollution; chemicals in homes, neighborhoods and workplaces; stress; and individual behaviors such as sleep and diet. The research will then relate these factors to genomic changes and clinical outcomes in newborns and beyond.

Of the four key pediatric outcomes being spotlighted in the research, Inova has been tasked with neurodevelopment and related conditions such as autism, behavior disorders and learning disabilities. The other three outcomes encompass airway conditions such as asthma and allergies; obesity and related conditions, such as diabetes and metabolic syndrome; and outcomes during pregnancy and just after birth, such as birth defects.

Inova’s ECHO assignment especially enthuses Drs. Huddleston and Niederhuber.

“All of the body’s systems come from brain development. The brain has so many different functions. I think Inova’s in the most exciting quadrant and definitely the one most open to discovery science.”

KATHI HUDDLESTON, PhD

As part of the ECHO grant, researchers like Kathi Huddleston, PhD, Director of Clinical Research Projects at Inova Translational Medicine Institute, use an iPad-based tool to assess children’s neurological development.

See how ITMI will help transform patient care. Download the Inova Magazine app at inova.org/moblie or search “Inova Magazine” in the Apple app store.

Innovations
It Really Does Take a Village

Just as successfully raising a child requires extensive cooperation, so too does successfully tracking children’s health and dissecting environmental, genomic and other factors causing and preventing disease.

The parents of more than 3,200 Inova’s littlest patients not only are integral to ongoing research here to champion personalized medicine, but they also now are key to a prestigious effort funded by the National Institutes of Health. From filling out periodic surveys to providing hair, teeth, tissue and stool samples on an ongoing basis, these families are the backbone of Inova Translational Medicine Institute’s robust research. “This is an amazing gift these families give by agreeing to participate in our research,” says Elisabeth Klein, DNP, an ITMI research investigator.

Eclectic Group of Clues

To assess children’s neurological development — including factors such as language development and processing speed — Inova will use an iPad-based tool that makes testing easy and fun for the 2- through 4-year-olds. Other clues to their environmental exposures will come from mothers’ hair samples, tissue samples collected during pregnancy and delivery, stress- and depression-related questionnaires, satellite-generated air quality readings, and the prized baby teeth.

“TOoth formation starts during development in the uterus, so teeth are literally beginning to put those layers on themselves even though the baby isn’t born and the teeth aren’t in their mouth yet,” Dr. Niederhuber notes. “Each layer is a reflection on the chemicals a baby is exposed to during gestation and until a tooth is shed.”

Even as more Inova families are enrolled in the research, ITMI will also be integrating information about health factors unveiled by more-recent scientific advances, such as those pertaining to the microbiome — the collection of microorganisms, mainly bacteria, inside and outside the body. Pediatric gastroenterologist Suchi Hourigan, MD, ITMI’s Director of Microbiome Research, will be collecting stool samples from Inova children several times between birth and early childhood to determine how their gut microbiomes correlate to their health and disease development. (Learn more about Dr. Hourigan’s study of the microbiome on page 10.)

“If bring all these large institutions together with a passion for childhood health, we can look at so many factors that lead to disease and see what’s uncovered,” Dr. Hourigan says. “We can also develop predictive models to prevent these diseases from happening. At the moment, that comprehensive data set we need is just not there.”

Genomics Adds Crucial Insight

Integral to the data set is sequencing Inova children’s DNA to determine how genes and environment blend to create — or avoid — health conditions.

“We can see if a person who was exposed to the same environmental element responds differently for a genetic reason,” says Thierry Vilboux, PhD, a senior translational research scientist at ITMI. “By gathering many patients, we may be able to find some genetic susceptibility, and after finding this, we may be able to help prevent a disease or identify people at risk. That’s why it’s very exciting.”

Collaborating in the ECHO research elevates not only Inova’s national profile but also its long-term sustainability efforts financially and educationally, Dr. Niederhuber says.

“If you want to be more competitive, you have to develop some understanding in the community that you’re supporting and fostering discovery,” he says, “because people with chronic diseases are always searching for where discoveries are taking place that might impact their health and wellness.”
A set of twins born prematurely at Inova Fairfax Medical Campus shared many things in common, including their early entrance into the world and vastly similar medical care. But only one of the babies thrived and went home, while the other died.

Why did their fates diverge? The answer rested in their guts: Stool samples showed the sick twin harbored more pro-inflammatory bacteria even when the baby appeared well, likely contributing to a fatal case of necrotizing enterocolitis, a condition severely eroding intestinal tissue.

The tragic situation highlights the importance of research by Inova pediatric gastroenterologist Suchi Hourigan, MD, to better understand the role of the microbiome in digestive and overall health. Comprised of the trillions of microorganisms — mainly bacteria, both good and bad — living on and in the body, the human microbiome’s role is becoming increasingly clear in functions such as digestion and warding off disease. A wide range of problems can result when the microbiome is out of balance, including inflammatory bowel disease, obesity, allergies, autoimmune disease and even developmental disorders.

“Every day in clinic, I treat children of all ages with health problems we’re now learning can be associated with their gut microbiomes,” says Dr. Hourigan, Director of Microbiome Research at Inova Translational Medicine Institute (ITMI). “As we learn more, the exciting work we do in the lab can directly help children we see each day.”

**Novel Studies Analyze Intestine, Bladder**

Dr. Hourigan brought seminal research in fecal transplantation to Inova when she arrived in 2013 after a fellowship at Johns Hopkins. Despite its undeniable “ick factor,” fecal transplants — which transfer stool from a healthy person to one with a microbiome imbalance — are proving quite effective. The U.S. Food and Drug Administration allows fecal transplants for patients with recurrent Clostridium difficile, dubbed C. diff, a potentially life-threatening intestinal infection.

Having witnessed the success of her first fecal transplant on an 11-year-old girl with C. diff who also suffered from the inflammatory intestinal disorder Crohn’s disease, Dr. Hourigan is now analyzing the procedure’s long-term health and microbiome effects in Inova children with C. diff, which can prove resistant to standard antibiotic treatment. Other research by Dr. Hourigan includes:

- **Neonatal intestinal microbiome development:** This ongoing effort is analyzing more than 120 premature infants at Inova. These babies are particularly vulnerable to microbiome imbalances due to many factors, including multiple medications and intravenous feeding. The study aims to determine why intestinal bacteria disturbances occur and how they may prompt health conditions. Stool samples are collected from these infants while in the NICU and every few months at home until age 3. Mothers’ breast milk and babies’ skin and saliva swabs are also gathered. “Even from that first stool, we can begin to see predictors of obesity or being overweight at 12 months,” Dr. Hourigan says.

- **Effects of gastric acid suppression on children’s intestinal microbiomes:** Babies with reflux, which causes profuse spitting up, are often prescribed acid-suppressing drugs that may also alter their gut microbiomes. “Stomach acid is needed to kill certain bacteria before it transmits to the intestines,” she explains. “If we’re suppressing acid, it will let different bacteria grow. This is a very novel study because we don’t know how this...”
You’re Not Alone in There

If you hate to eat alone, don’t worry: you never have. The human digestive system hosts 100 trillion or so bacteria, most of which are drawn from 30 or 40 different species. But, by itself, the colon is Grand Central Station: 10 trillion cells per gram of content (digested and undigested), representing 300–1,000 different species.

The four most common bacterial phyla found in the human digestive system:

- **Firmicutes**
- **Bacteroidetes**
- **Actinobacteria**
- **Proteobacteria**

works in children.” Children’s stool samples are collected before and after acid-suppressant use.

Urinary microbiome analysis: The urinary system has its own microbiome despite misconceptions that it’s sterile, Dr. Hourigan says. Urine samples are being collected from children whose Inova emergency room treatment necessitates catheterization. “It’s a very novel, exploratory study,” she says, “and we are excited to see the results.”

Microbiome Research Tied to Genomics

Until relatively recently, the microbiome’s effects on human health were underrecognized. But the advent of next-generation gene sequencing technology in the early 2000s enabled scientists to similarly scrutinize these bacteria, whose genes far outnumber the 20,000 or so in the genome.

ITMI’s mission to promote precision medicine — integrating genomic research into patient care, disease prevention and wellness — goes arm in arm with Dr. Hourigan’s microbiome studies in a way that will ideally benefit Inova’s pediatric patients as well as adults down the road.

“What are the things babies are telling us with their microbiomes?” muses ITMI research investigator Elisabeth Klein, DNP. “Can this knowledge help us predict things we might eventually be able to prevent? That’s the whole goal of personalized health.”

Learn more about Dr. Hourigan’s projects and the microbiome at inova.org/itmiresearch.
Lani Weiss benefited from the Inova MediMap VIP 360° test, which analyzes 18 genes that may influence responses to 118 medications. Thanks to the test, her doctor knew a medication she was taking was wrong for her.
Inova’s MediMap VIP 360° helps physicians prescribe the best medication and dosage to fit a patient’s unique DNA

Lani Weiss didn’t feel well. “I was always exhausted, my face felt numb and I had trouble putting words together,” Lani recalls. When the symptoms persisted, the 50-year old Centreville resident made an appointment to see Craig Cheifetz, MD, FACP, Medical Director for Inova’s VIP 360° Concierge Medicine Program.

Dr. Cheifetz asked his patient if she was taking any new medication — and she was. A physician not associated with Inova had prescribed a medication to promote better sleep. Dr. Cheifetz reviewed Lani’s Inova MediMap VIP 360° test results and saw that this medication fell into her red column, meaning she was at high risk for side effects with a low chance for drug efficacy.

“Dr. Cheifetz took me off the drug immediately and within a few days, the debilitating side effects were gone. For me, the MediMap test had an extremely significant impact on my health,” Lani says.

Genomics at Work
MediMap is based on pharmacogenomics (PGx), which combines the science of how medications work (pharmacology) with the science of how genetic differences can influence health (genomics). PGx testing predicts how a person’s unique genetic makeup may respond to certain prescription medications. In other words, PGx testing guides a physician to prescribe the best medication and dosage for an individual and thus reach the healthiest possible goal.

The Inova MediMap VIP 360° test, which involves a noninvasive swab inside the cheek to obtain a DNA sample, analyzes 18 genes that may influence responses to 118 medications. The panel of medications falls into 11 categories: anti-ADHD, anti-anxiety, anti-depressants, bladder control, cardiovascular, diabetes, gastrointestinal, neurology, pain, rheumatology and sleep.

MediMap VIP 360° does not test for allergic reactions to medications, nor does it look at genes related to disease risk. Those are different tests that also belong in a patient’s medical record.

“Pharmacogenomics is groundbreaking personalized medicine,” says Dr. Cheifetz, who helped develop the MediMap VIP 360° test, which is now offered exclusively to Inova’s VIP 360° concierge members and executive health clients for a fee.

Sometimes Less Is More
Identifying a patient’s correct dosage for a particular medication is a significant MediMap benefit. Take Washington, DC, resident Clifford Hodson. “I had hip and knee irritation and everyone assumed it was because I am 54 and play a lot of touch rugby. But when I saw Dr. Cheifetz, he wasn’t convinced it was a sports-related injury. He suggested I take the MediMap test.”

Dr. Cheifetz’s hunch was right. “Clifford has high cholesterol and we had him on a statin, but MediMap told us that his dosage put him at high risk for developing muscle pain,” Dr. Cheifetz explains. “So we reduced the dosage and went to every other day. That resolved his side effects and the statin is still doing exactly what we want it to.”

For Clifford, MediMap also brought peace of mind. “People have become so blasé about taking prescription drugs. I want to know what I’m putting in my body, if a prescription is safe for me and exactly what the side effects might be. MediMap gives me those facts — so I feel very safe taking what Craig prescribes.”

Clifford’s situation is not uncommon, Dr. Cheifetz explains. “A lot of times people have side effects to a medication and the physician or patient abandons the medication — when the right answer is to adjust the dosage,” he says. “But how much do we adjust for this patient versus that patient? MediMap helps us individualize prescription amount and frequency. Now we’re talking about personalized medicine.”

Physician, Heal Thyself
Dr. Cheifetz is more than a MediMap proponent; he’s also a patient. “I had it done on myself and after reviewing the results, I changed one of my medications to avoid possible future side effects. And I found out that a common drug used for heart attacks and strokes won’t work for me. So if such an emergency ever happens, we would need to use an alternative drug. That’s lifesaving information!”

And this information remains pertinent forever, meaning that the MediMap is a one-time test. However, Dr. Cheifetz emphasizes, as the science of pharmacogenomics advances, new information on more genes and medications may be added to a patient’s test results.
The human genome, meaning a human's complete set of DNA, was first sequenced in 2003. This gave genomic researchers a blueprint for the building blocks that make each person unique. It was a groundbreaking step toward transforming healthcare from reactive to predictive.

Initially, the near-$3 billion cost to sequence one human genome presented a significant challenge. Today, that cost hovers around $1,000 per sequence, which spurred enormous collections of human genome sequence information. This created a new challenge: how to manage genomic big data in a meaningful way.

The Scale of Sequencing
To grasp the enormity of genomic big data, consider this. One human genome sequence requires about 140 gigabytes of storage space. This is roughly equal to storing 140 iTunes movies on a laptop, which typically has around 250 gigabytes of hard drive storage.

Now consider Inova Translational Medicine Institute (ITMI), established to explore how genomics can advance personalized and preventive medicine to improve the health of Inova's patients. ITMI today supports around 10,000 human genome sequences — the equivalent of 10 times the size of the information stored in the 36 million books at the Library of Congress.

Intensifying data storage needs, collecting human genome sequences requires more than straight-up storage space.

How to Measure Return
So what is the return on Inova's investment in genomic research? John Deeken, MD, ITMI Chief Operating Officer, says that is impossible to measure. “Transforming healthcare from reactive to predictive — and saving lives — has immeasurable value,” he says.

Therefore, Dr. Deeken and his team measure Inova's return in terms of current and future benefits to patients. As an example, while genomics is still in its infancy, Inova's leadership in the field is helping to recruit national and international experts. “We spent a lot of time and money to create the highest quality data that can support state-of-the-art research. It's an asset that attracts the most talented physicians to Inova,” Black stresses. “These doctors want to be here — at the forefront of discovery. That gives our patients access to specialists they wouldn't otherwise have.”

The high quality of ITMI's big data bank also attracts researchers poised to advance Inova's visionary initiative to bring personalized medicine to Northern Virginia and the world. Case in point: Inova's recent creation of...
a Global Genomics and Bioinformatics Research Institute, representing a public/private partnership between the Commonwealth of Virginia, distinguished Virginia universities and the state’s technology community. To be located on the 117-acre Inova Center for Personalized Health campus in Falls Church, the institute will bring together world-class scientists to collaborate on the advancement of genomics as it relates to predictive healthcare, personalized medicine, groundbreaking big data management and advanced analytics.

**Studying Up**

Major genomics studies also are paying dividends in patient care and treatment. These include ITMI’s Premature Birth Study, which focused on creating whole genome sequencing for 1,028 families and then analyzing the data to determine possible genetic or biochemical links to premature birth.

The study’s findings, which will be published soon, have already delivered clues to help predict and prepare for premature birth. More exciting, Dr. Deeken adds: “This data may help us to someday discover ways to predict and prevent premature delivery.”

One personalized medicine study also has earned a major federal grant. That study, the Fairfax Childhood Longitudinal Childhood Genome Study, which Inova initiated in 2012, is one of the largest multigenerational projects of its kind. More than 3,400 children and families have already been enrolled. Genomic, clinical, environmental, nutritional and psychosocial factors as they relate to each family are continuously updated — from the time each child is born until he or she reaches 18 years. The goal is to identify children with shared risk factors for health and developmental issues and in turn help researchers advance personalized medicine and preventive healthcare.

The project earned ITMI a $9.5 million, seven-year grant from the National Institutes of Health (NIH) to study environmental influences on childhood health. Learn more about the Environmental Influences on Child Health Outcomes (ECHO) study on page 6.

“This collaboration will lead to discoveries that correlate with childhood diseases and neurological, brain and physical development,” Dr. Deeken says. “The next step will be developing therapeutic interventions to treat diseases and developmental issues — or better yet, prevent them in the first place.”

That, Dr. Deeken says, is the ROI Inova is looking for.
COME ON, GET APP-Y
Take Inova’s expertise with you wherever you go by downloading the Inova app to your mobile device.

Peace of Mind: Why You Need an Advance Healthcare Directive
If you’re like most people, you have opinions about how you’d like to be cared for in a medical emergency or at the end of your life. But if you’re like most people, you haven’t done enough to share those wishes …

It’s Not just Irritable Bowel
Digestive troubles could signal a common, but often overlooked, condition called small intestine bacterial overgrowth, or SIBO …

Is Genetic Testing Always a Good Idea?
The field of genetic testing has grown dramatically in the last few years. That’s a good thing, since patients now have more options to check for genetic traits that might put them at increased risk of developing diseases like cancer or heart disease …

Colon Cancer in Young Adults: Know Your Risk
March is Colorectal Cancer Awareness Month, and I always applaud efforts to raise awareness of this disease — the fourth most common cancer in the United States, and the second leading cause of cancer death …

& For more of these and other stories, please visit us at inovanewsroom.org.

What’s New in InHealth
Check out the most recent issue of Inova’s newsletter InHealth, covering the latest developments at Inova’s five hospitals, plus inspiring recovery stories and tips for overall health and wellness.

Spring/Summer 2017
- Advanced robotic surgery at Inova Alexandria Hospital
- Baby Eliza thrives thanks to the cardiac services on Inova Fairfax Medical Campus
- Outpatient hip surgery at Inova Fair Oaks Hospital helps outdoorsman stay active
- Major heart care renovations at Inova Loudoun Hospital
- Advanced spine imaging technology at Inova Mount Vernon Hospital

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