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Spring 2016

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Consortium Aims to Create Kidneys in the Lab

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Transplant Nephrology and Kidney Transplantation

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- Super-resolution microscopy illuminates kidney diseases
- Current clinical trials

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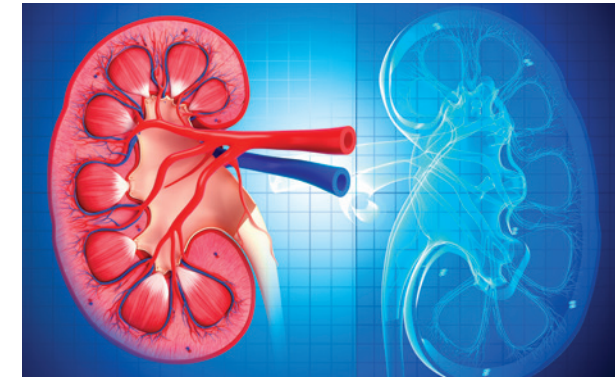
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Consortium Aims to CREATE KIDNEYS IN THE LAB

FOR PATIENTS WITH END-STAGE KIDNEY DISEASE AWAITING AN ORGAN TRANSPLANT, THE PROSPECTS CAN SEEM BLEAK. BECAUSE OF A SHORTAGE OF DONORS, MANY PATIENTS ON THE WAITING LIST DIE BEFORE A DONOR KIDNEY BECOMES AVAILABLE.

BUT A WASHINGTON UNIVERSITY nephrology researcher is part of an international group trying to change that. Called ReBuilding a Kidney, the group is a consortium of research teams at 13 institutions working toward a common goal: creating a kidney in a lab. →

“The core principle of the consortium is the idea that stem-cell technologies are at a point where we can envision growing a kidney for transplantation,” says Benjamin Humphreys, MD, PhD, chief of the Division of Nephrology at Washington University School of Medicine. “We work toward that goal in a collaborative fashion.”

“There are more than half-a-million patients with kidney failure and not enough donor kidneys to go around. Expanding the donor pool won’t solve this problem, which makes it all the more important that we make a collaborative effort to grow a kidney as quickly and efficiently as possible.”

— Benjamin Humphreys, MD, PhD

Until very recently, growing a kidney in a lab seemed impossible. But new research has shown that it is not necessary to grow the 30-plus distinct cell types that make up the kidney and arrange them in proper orientation. Instead, researchers can coax pluripotent stem cells to differentiate into just two types of kidney-specific stem cells and then combine them, which enables the cells to continue to differentiate, generating many of the cell types found in a mature kidney.

“This discovery simplifies the problem dramatically,” Humphreys says. “It has made our attempt worth considering.”

The laboratories involved in ReBuilding a Kidney are located across the United

States and in Australia. Each lab provides a particular type of expertise. Humphreys and his team are experts in the repair and regeneration of adult kidneys. Their role in the consortium is to help design strategies that would enhance the repair of damaged lab-grown kidneys and prevent them from becoming diseased.

Image courtesy of Benjamin Humphreys, MD, PhD

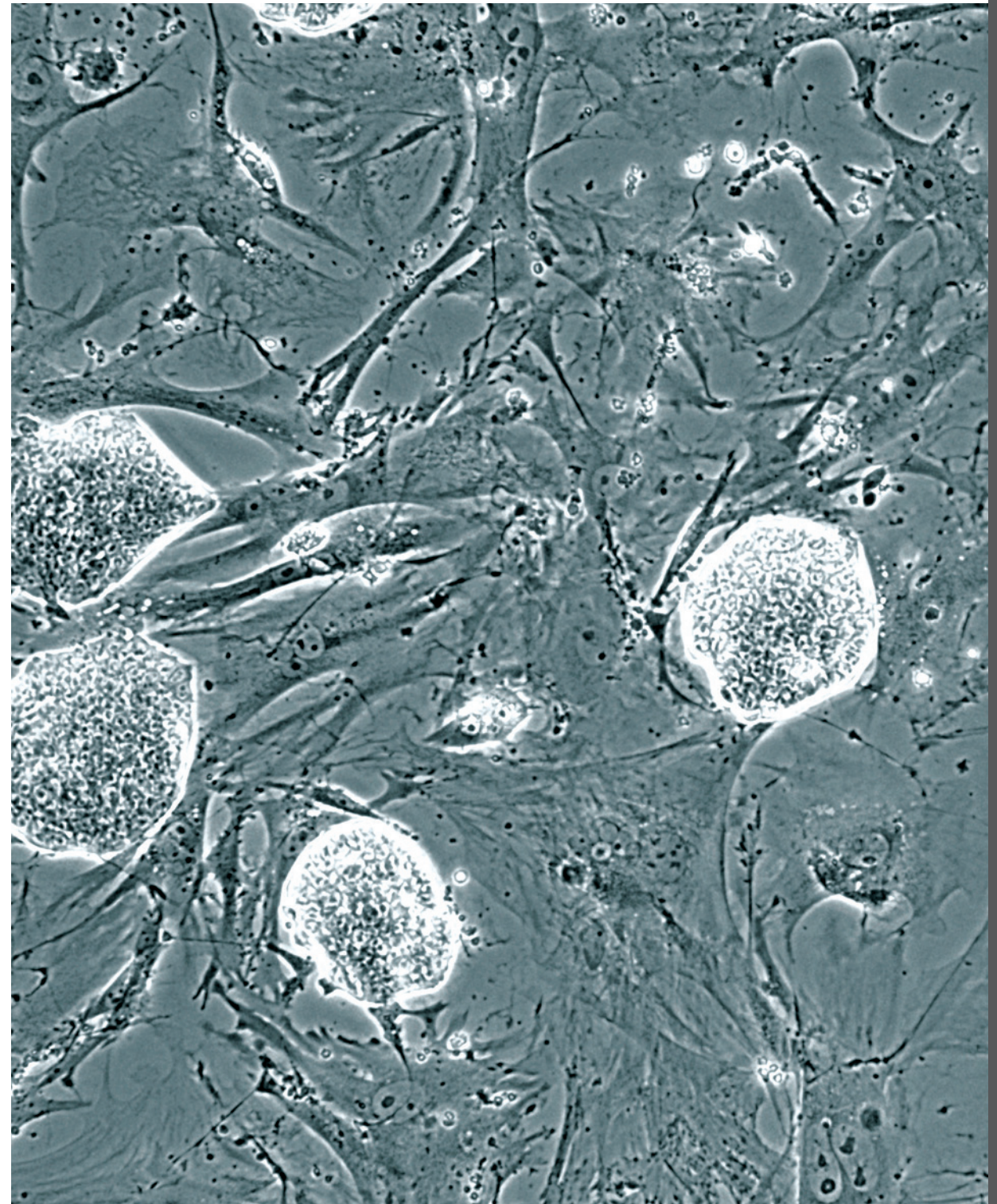
“If we are successful in growing a kidney in a dish, that dish will be a foreign environment that will inevitably trigger injury in vitro. We need to have strategies to keep that kidney healthy,” Humphreys says.

In research published in 2015 in the journal *Cell Stem Cell*, Humphreys and colleagues found that in injured kidneys, cells that express the *GLI-1* gene proliferate and generate new cells called myofibroblasts, which in turn secrete scar proteins that build up and impair kidney function. The researchers are now working on strategies to inhibit these *GLI-1*-positive cells with the goal of preventing scarring in lab-grown kidneys.

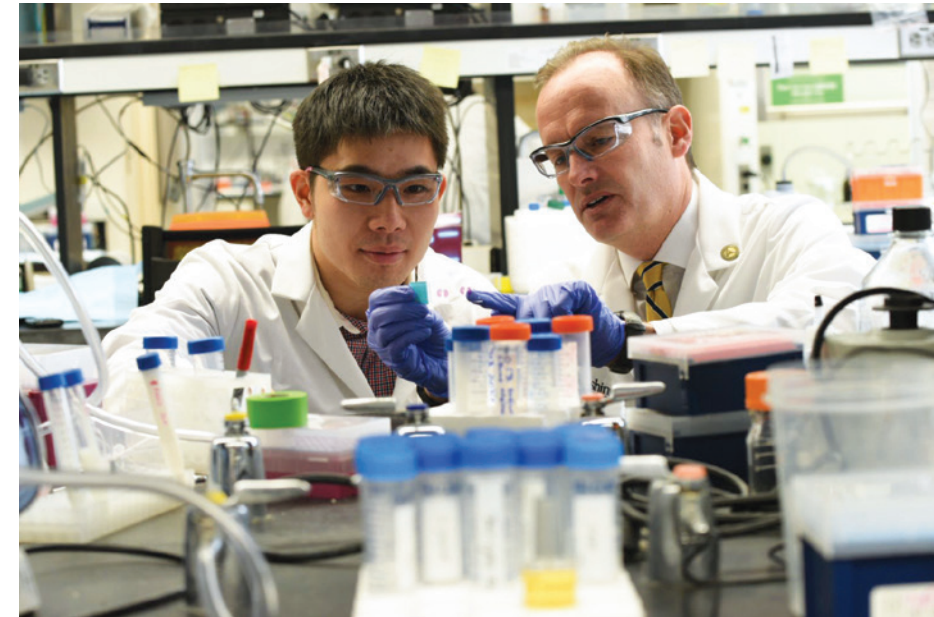
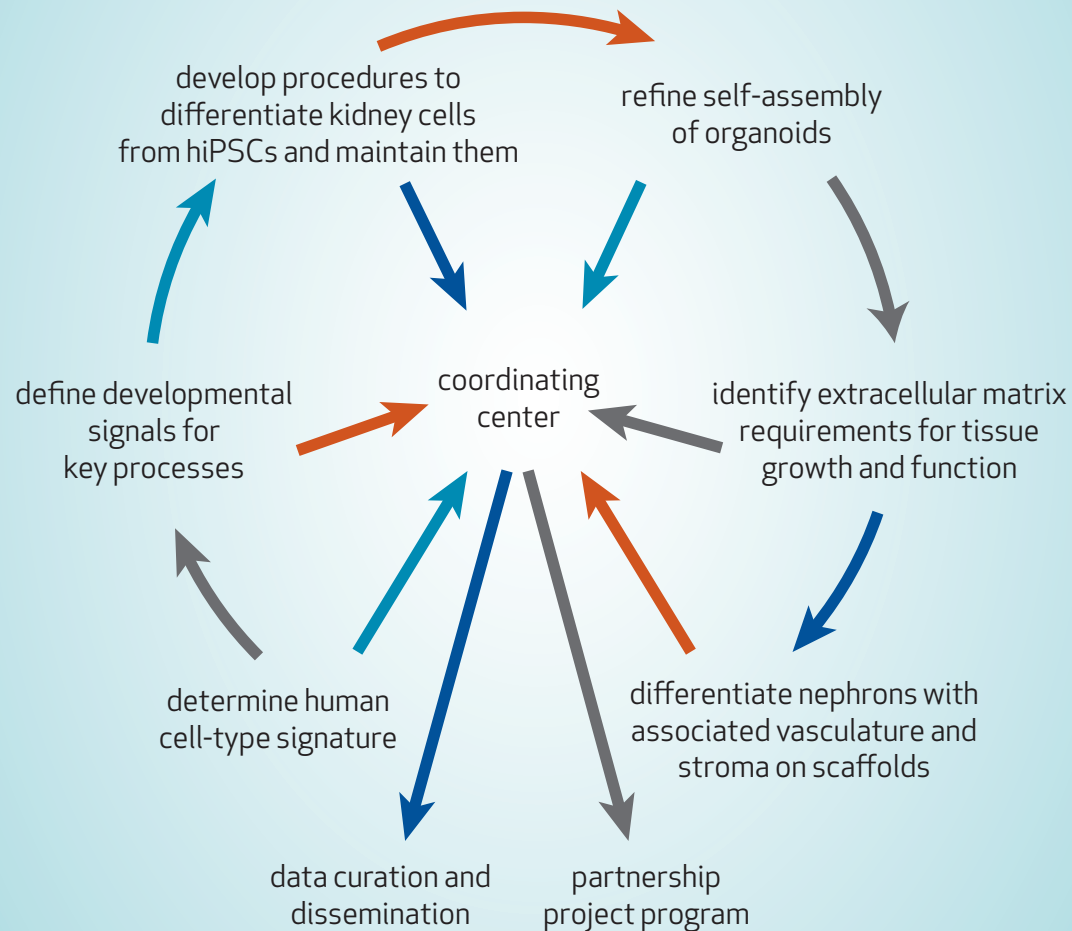
If these strategies are successful, they may also be applicable as treatments for patients with kidney failure.

“There is no guarantee that we will be able to grow a kidney in a dish any time soon,” Humphreys says. “But if we are successful in developing a drug to protect lab-grown kidneys from damage, there is no reason to think that the drug couldn’t be used to treat patients with failing kidneys.”

The ReBuild a Kidney project benefits from groundbreaking work conducted by Humphreys’ immediate predecessor, →



ReBuilding A Kidney Consortium Process Diagram



Benjamin Humphreys, MD, PhD, (right) works in the lab with postdoctoral research associate Yoichiro Ikeda, MD, PhD.
Photo by Robert Boston

Marc Hammerman, MD, who spent decades contributing to the knowledge base in the related area of renal primordia transplantation.

In other research for ReBuilding a Kidney, Humphreys and colleagues have identified an epithelial cell population that repairs damaged nephrons, the structures in kidneys that produce urine. Their goal is to isolate these cells and combine them with stem cells to produce mature nephrons in a lab-grown kidney.

The National Institute of Diabetes and Digestive and Kidney Diseases, part of the National Institutes of Health (NIH), provides funding for the consortium in a way that sets the project apart from traditional NIH-supported research. Rather than funding single labs that are investigating separate questions, the agency has charged each group in the consortium to work collaboratively toward a common goal.

“Traditionally, labs have worked independently, often not sharing their data

until it was published,” Humphreys says. “But a condition of our funding from the NIH requires us to share our knowledge and reagents with one another in real time. This helps spread knowledge more rapidly.”

Building on previous work in mice, Humphreys and his team have begun generating the two relevant pluripotent stem-cell populations from human cells. In addition, they are working with the Genome Engineering and iPSC Center at Washington University to genetically modify some of the stem cells, a collaboration that Humphreys says accelerates their work.

“There are more than half-a-million patients with kidney failure and not enough donor kidneys to go around,” Humphreys says. “Expanding the donor pool alone won’t solve this problem, which makes it all the more important that we make a collaborative effort to grow a kidney as quickly and efficiently as possible.” ■



Computer artwork of the capsid of a polyoma BK virus. The Washington University transplant nephrology team at Barnes-Jewish Hospital has developed a treatment approach that can prevent patients from developing BK virus after transplantation.

©Science Photo Library

TRANSPLANT NEPHROLOGY AND KIDNEY TRANSPLANTATION

WRITTEN BY PAM MCGRATH

Responsible for medical management of kidney recipients and living donors prior to and following surgery, the Washington University transplant nephrology team at Barnes-Jewish Hospital plays a significant role in the transplantation process, more so than is found in similar programs across the country, says Daniel Brennan, MD, director of transplant nephrology. →



BY THE NUMBERS: TRANSPLANT NEPHROLOGY AT WASHINGTON UNIVERSITY AND BARNES-JEWISH HOSPITAL

No. 10 nephrology program in the nation, U.S. News & World Report

4,600 kidney transplants since 1963

230 kidney transplants annually

50 percent of all kidney transplants in Missouri

Brennan leads a group of five full-time transplant nephrologists and two general-practice nephrologists. “I think most transplant programs promote a team approach to patient care, but in our case I can say the transplant nephrologists and surgeons truly are committed to working together for the good of our patients,” Brennan says. “We round together daily, and we work within a multidisciplinary committee that also includes pharmacists, immunologists, social workers and others to make decisions about a patient’s eligibility for inclusion on the kidney-transplant wait list.”

“The fact is that we are committed to caring for these patients throughout their lifetime, sometimes as their primary care physicians, other times in partnership with referring nephrologists. It is among the most exciting, challenging and rewarding aspects of nephrology, and we are fortunate to be part of one of the premier transplant programs in the nation.”

— Daniel Brennan, MD

That kind of teamwork has yielded significant contributions to the field of kidney transplantation. Among these is pioneering the use of the drug Thymoglobulin to prevent organ rejection. In use at Barnes-Jewish Hospital since 1996, the drug has helped the kidney-transplant team keep its rejection rate at around 5 percent; nationally, the average is 10 to 15 percent.

“We also developed a treatment approach that prevented patients from developing BK virus as a result of taking a combination of tacrolimus and

mycophenolate,” says Brennan. “This powerful drug regimen can result in over immunosuppression that triggers viral reactivation, in particular BK virus. National statistics show that when this happened in patients, half of them lost their transplanted kidneys, and the others were left with a chronically dysfunctional kidney.”

Signs of the BK virus are detectable first in urine and blood. To prevent progression to nephropathy, Brennan and colleagues began removing the antimetabolite mycophenolate from the immunosuppressive regimen as soon as a patient’s blood tests were positive for the BK virus. This treatment approach has been adopted worldwide.

“We work hard to develop and refine immunosuppressive therapy to prevent rejection and infection,” says Brennan. “As a result of this work, our transplant program has one of the lowest delayed-kidney-transplant-function rates in the world, ranging from 5 to 12 percent annually.”

Brennan notes that a major change has occurred in recent years in the increased number of kidneys coming from living related and unrelated donors. At Barnes-Jewish Hospital, 22 to 24 percent of the kidney transplants performed annually involve living donors.

“Equally exciting is the growth of our paired-kidney-exchange program. We initiated our program in 2009, when we worked with Johns Hopkins Hospital in Baltimore and Baptist Integris Medical Center in Oklahoma City to create a paired-kidney exchange involving 12 patients. At that time, it was the largest kidney swap performed in the United States,” says Brennan. →

“Two weeks later, our team performed its first paired-kidney exchange with patients exclusively from Barnes-Jewish Hospital. The complexities of these exchanges, which require multiple surgical teams performing surgeries simultaneously, simply are not possible at a smaller transplant center.”

Barnes-Jewish Hospital now participates in paired-kidney-exchange programs sponsored by the United Network for Organ Sharing, the National Kidney Registry and Johns Hopkins Hospital. “In addition, we are beginning the process of implementing an internal paired-donation program that would use our own donors and recipients,” says Brennan. “Every living-donor transplant we can arrange decreases the competition for deceased-donor organs—an important consideration for the approximately 850 Barnes-Jewish Hospital patients currently on the kidney-transplant wait list.”

With the number of people awaiting kidney transplants continually growing—the National Kidney Foundation puts the number in the United States at more than 100,500 as of January 2016—the transplant nephrology team at Barnes-Jewish Hospital works to identify and encourage living donors. For instance, a donor-champion

program encourages friends and family of a patient on the kidney-transplant wait list to broadcast the patient’s need through word of mouth and social media.

“Patients may be uncomfortable asking for kidneys, but family and friends often are willing to because they want to be actively involved in helping to save the life of a loved one,” Brennan says. “We also suggest to patients that when someone asks them how they are, they should tell the truth: ‘I’m not too well, my kidneys have failed, and I’m trying to get a kidney transplant.’ The chances of finding an altruistic donor increase when an increasing number of people understand the need.”

Transplant nephrologists are intimately involved throughout the transplantation process, from pre-transplant work gathering medical histories and ordering screening tests to post-transplant work monitoring immunosuppressive drugs, possible side effects and signs of rejection.

“The fact is that we are committed to caring for these patients throughout their lifetimes, sometimes as their primary care physicians, other times in partnership with referring nephrologists,” says Brennan. “It is among the most exciting, challenging and rewarding aspects of nephrology.” ■



GENETIC APPROACH GUIDES TREATMENT FOR AHUS

A novel genetic approach still under development appears to identify which patients with atypical hemolytic uremic syndrome (aHUS) will benefit from the only available drug treatment.

Unlike typical hemolytic uremic syndrome, which results from a Shiga toxin-producing *E. coli* infection, aHUS is often caused by mutations in genes controlling the body's complement system. The disease causes abnormal blood clots to form in the kidneys and is characterized by three major symptoms: hemolytic anemia, low platelet count and kidney failure.

Eculizumab, which inhibits the complement system, is the only drug that has been used successfully to treat aHUS. But it costs hundreds of thousands of dollars per year, and not everyone with aHUS benefits.

"Sometimes a mutation found in the complement system of a patient with aHUS is benign, without any functional consequence, and isn't actually the cause of the disease," says Washington University nephrologist and researcher Anuja Java, MD. "In those cases, there is no need to prescribe eculizumab and cause the patient to incur the cost of the therapy."

Java's research has definitively shown whether particular mutations actually cause aHUS or are benign. In the first step

of the process, she sends a blood sample from a patient to Washington University's Genomics and Pathology Services, where DNA is extracted to test for mutations affecting the patient's complement system. If the results reveal a novel mutation that has not already been characterized as either pathogenic or benign, Java can re-create that mutation in the lab and test the function of the resultant protein. If the tests confirm that the complement protein is dysfunctional, she knows the mutation is pathogenic and is causing aHUS in the patient.

"This helps me stratify patients," Java says. "If a mutation is causing the disease, I know the patient needs treatment with eculizumab. But if the mutation is not causing the disease, we should not commit to treatment with eculizumab and instead follow the patient closely, addressing symptoms as needed."

Java is the first to use this method for testing mutations in patients with aHUS. The standard method for deciding whether to treat a patient with eculizumab is to use online programs that predict whether a mutation is pathogenic or benign. These computational

programs use evolutionary conservation (presence of similar genes across different species) and frequency of the mutation in the general population as criteria to determine whether a mutation is likely disease-causing. This method is predictive; Java's is designed to be definitive.

So far, she has tested mutations for about a dozen patients, most of whom were in end-stage renal disease and being considered for kidney transplantation. She has also tested mutations for a few patients who have undergone transplantation because they face the possibility of disease recurrence if their conditions stem from mutations and are left untreated.

The process of creating and testing mutations is lengthy, typically taking six to eight weeks. Java's long-term plan is to streamline the process and get test results to patients within a few days.

"I am applying for a grant to continue this work so we can provide more patients with definite answers," Java says.

— A. MONGLER

RENAL DIVISION HOSTS FIRST MIDWEST TRANSPLANT SYMPOSIUM

Washington University School of Medicine's Division of Nephrology hosted the first Midwest Transplant Symposium, in St. Louis, Missouri, in the fall of 2015. "Our goal," says Tarek Alhamad, MD, MS, director of transplant epidemiology research collaboration, "was to provide professionals in the field opportunities for education and networking, as well as an overall review of renal and pancreas transplantation."

The division's team of transplant specialists performs approximately 250 kidney transplants per year with an acute rejection rate of less than 5 percent—one of the lowest in the United States. "The symposium allowed us to share our knowledge and learn from others so we can all work to improve the quality of life of renal transplant patients," Alhamad says.

Alhamad and Daniel Brennan, MD, FACP, medical director of transplant nephrology, co-directed the event, which featured a multidisciplinary panel of experts presenting recent advances and new techniques in the fields of renal and pancreas transplantation. Anil Chandraker, MD, medical director of kidney and pancreas transplantation at Brigham and Women's Hospital presented "Immunosuppression: Standards and Alternatives." Milagros Samaniego, MD, medical director of kidney and pancreas transplantation at the University of Michigan, presented "Antibody Mediated Rejection." Participants included general physicians, nephrologists, nurse practitioners, nurses and pharmacists.

"Our transplantation program has made significant strides in

understanding viral infections," says Brennan. "We've made contributions to the literature that have changed practice patterns." His symposium presentation discussed the positive effects of valganciclovir (VGCV) in the prevention of cytomegalovirus. He also notes that the team manages the BK virus in ways that differ from other transplant programs. (To read a story about research on this topic, turn to Page 6.)

Transplant coordinator Trisha Swick presented information about the Kidney Allocation System (KAS), which was implemented by the U.S. Department of Health and Human Services' Health Resources and Services Administration in December 2014. Among other changes, Brennan notes, "the new system allows for the more desperately ill to move to the front of the wait list. Wait time starts when a patient begins dialysis or has a kidney function of less than 20 percent."

Alhamad discussed the benefits of simultaneous pancreas and kidney transplantation (SPK). "This is one of the most



From left to right: Daniel Brennan, MD, FACP, and Tarek Alhamad, MD, MS, co-directors of the first Midwest Transplant Symposium

problematic areas in renal transplantation," he says. "In regions where the wait times for a donor pancreas are shorter, SPK offers better survival than kidney transplantation alone. And it's the best treatment for patients with type I diabetes mellitus with end-stage renal disease."

The symposium's workshops offered participants the opportunity to exchange information and discuss interesting cases and advances in care. Both Brennan and Alhamad note that, thanks to the success of the first event, the symposium will become an annual opportunity for collaboration.

— S. FECHTER

SUPER-RESOLUTION MICROSCOPY ILLUMINATES KIDNEY DISEASES

A new, powerful form of microscopy is providing insights that may increase the understanding of how best to treat kidney diseases.

With traditional light microscopy, it's not possible to image anything smaller than 200 nanometers. In 2014, three researchers—two from the United States and one from Germany—were awarded the Nobel Prize in Chemistry for figuring out how to break that barrier with a technique called super-resolution microscopy.

Today, investigators at Washington University School of Medicine are using super-resolution microscopy to image molecular details within kidney cells.

"With traditional light microscopy, we can look at the gross organization of a tissue or cell," says immunobiologist Andrey Shaw, MD. "But with super-resolution microscopy, we can look at individual molecules and see how those molecules are organized to generate tissue."

Shaw is part of a team of investigators who used super-resolution microscopy to look at the organization of molecules in the glomerular basement membrane. Using mouse and human tissue, they discovered that these molecules are arranged in layers. "Previously no one had seen these layers, but now that we have, we

can look at how they are affected in various diseases," Shaw says.

In the same study, published in *eLife* in 2013, the investigators found disruptions in the glomerular basement membrane in a mouse model of Alport syndrome, a rare genetic condition characterized primarily by kidney disease. "This gives us insight into understanding why Alport syndrome occurs and informs approaches for coming up with a treatment," says molecular biologist Jeffrey Miner, PhD, one of Shaw's co-investigators.

The researchers are currently using super-resolution microscopy to image cells adjacent to abnormal type IV collagen in the glomerular basement membrane. Abnormal type IV collagen plays a role in Alport syndrome. The team also is imaging normal and diseased mouse and human kidneys to see how the cytoskeleton changes during disease. Their ultimate goal is to find a way to modulate the cytoskeleton to prevent or reverse disease.

In a study published in *Molecular Cell Biology* in 2013, the investigators used super-resolution microscopy to image kidney cells called podocytes. Injury to

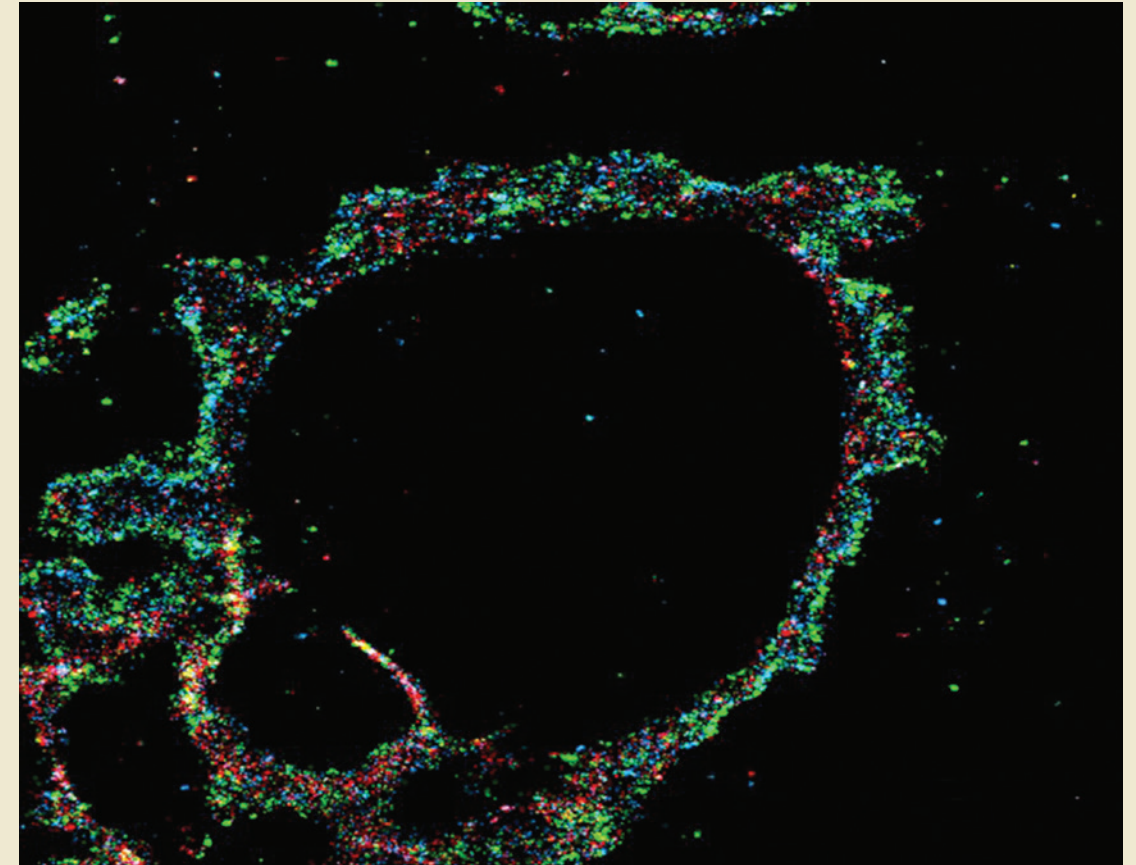
podocytes results in a process called foot process effacement, which is associated with many types of kidney disease. Using a mouse model, the researchers pinpointed the mechanism that causes foot process effacement.

"Trying to understand how the podocyte functions is the holy grail for the kidney field," says molecular biologist Hani Suleiman, MD, PhD, another co-investigator.

Suleiman and colleagues are now looking at human samples to see if what they learned about podocyte injury in their mouse model applies to human kidneys. They are also using super-resolution microscopy to understand diseases such as diabetic nephropathy and focal segmental glomerulosclerosis on a molecular level.

"We are studying the kidney, but this method could be applied in any other tissue," Suleiman says. "It's a new era of microscopy."

— A. MONGLER



Triple-color stochastic optical reconstruction microscopy (STORM) image of collagen IV $\alpha 3$ KO mouse kidney, a model for Alport disease that affects the mature collagen IV $\alpha 3\alpha 4\alpha 5$ trimers. Kidney glomeruli were stained with integrin b1 (green), agrin (blue) and fibronectin (red) and imaged by STORM. Irregularly thickened areas of the glomerular basement membrane are fibronectin positive.

Image courtesy of Hani Suleiman, MD, PhD

GENETIC RESEARCH SEEKS THERAPEUTIC TARGET FOR GORDON SYNDROME

Novel genetic research has revealed a potential therapeutic target for Gordon syndrome. Also called pseudohypoaldosteronism type 2, Gordon syndrome is characterized by hypertension, hyperkalemia and metabolic acidosis. Though its prevalence is unknown, the condition is very rare.

“Because it is so rare and because it involves very high blood pressure, Gordon syndrome can be devastating,” says molecular cell biologist Jianghui Hou, PhD. “But it is difficult to study because so few patients have it.”

Mutations in four different genes, which lead to problems regulating the amounts of sodium, potassium and chloride in the body, are known to cause Gordon syndrome. The regulation of sodium, potassium and chloride occurs primarily in the kidneys.

In new research, Hou and co-investigators at Washington University deleted a protein called claudin-8 in a mouse kidney. This resulted in hypotension,

hypokalemia and metabolic alkalosis—symptoms that are the exact opposite of those found in Gordon syndrome. Mechanistically, the claudin-8 protein is the primary molecular component of the kidney’s chloride shunt pathway, or chloride reabsorption pathway. Through this pathway, chloride from the body is reabsorbed in the kidneys.

The investigators found that the *claudin-8* gene interacts with *Kelch-like 3 (KLHL3)*, one of the genes known to be involved in Gordon syndrome. Patients who inherit recessive mutations in *KLHL3* invariably develop Gordon syndrome, suggesting that loss of *KLHL3* function leads to the condition. Using both cell

and animal models, Hou and his colleagues found that loss of function in *KLHL3* resulted in overexpression of claudin-8, leading to hyperabsorption of chloride and hypertension, the hallmarks of Gordon syndrome.

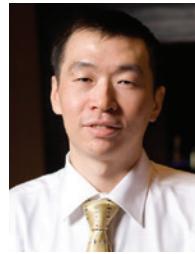
“Our research suggests that inhibitors acting upon claudin-8 and the chloride shunt pathway may represent an effective treatment for Gordon syndrome and other related hypertension,” Hou says.

In addition to investigating new drugs that would regulate the chloride shunt, Hou plans to study this pathway beyond the kidney.

“The chloride shunt is part of a bigger story,” he says. “It also plays a role in the blood-brain barrier, so it can affect diseases such as multiple sclerosis and Alzheimer’s. Increased understanding of the chloride shunt and the discovery of small molecules that may regulate it will allow us to study the blood-brain barrier and related diseases.”

— A. MONGLER

In vivo telemetric blood pressure recording comparing claudin-8 knockout (KO) and littermate control (CON) animals over a 24-h period. Data are presented as the mean arterial pressure \pm SEM over time at 2-h intervals. * $P < 0.05$, $n = 3$.



Jianghui Hou, PhD

NEW PARTNERSHIP YIELDS IMPROVED RENAL CARE IN GUATEMALA CITY

In response to the occurrence of an unusual, chronic kidney disease (CKD) in Guatemala, Washington University physicians in the Division of Nephrology have formed a partnership with physicians at San Carlos University Medical School and the kidney unit at the Instituto Guatemalteco de Seguridad Social, both in Guatemala City. The partnership has garnered global recognition for its efforts to offer advanced training to physicians in developing countries and innovations in treatment in the field of nephrology. The Mentors in Medicine (MiM) program at Washington University, a pivotal part of the partnership, sponsors fellowships for Guatemalan physicians.

Marcos Rothstein, MD, FACP, a Washington University nephrologist at Barnes-Jewish Hospital, leads the school’s MiM program and notes that it is involved in developing treatment plans and long-range strategies for education, research and clinical support, in addition to providing funding for advanced training programs and new protocols.

In 2014, Erick Herrera-Escobar, MD, a graduate of San Carlos University Medical School, began the first of two consecutive fellowships at Washington University School of Medicine. Herrera-Escobar and another recent fellowship recipient, Ever Cipriano, MD, have completed their training at Washington University in advanced vascular access placement and returned to Guatemala to share their knowledge. “The skills they acquired in St. Louis are already making a difference in Guatemala City,” Rothstein says.

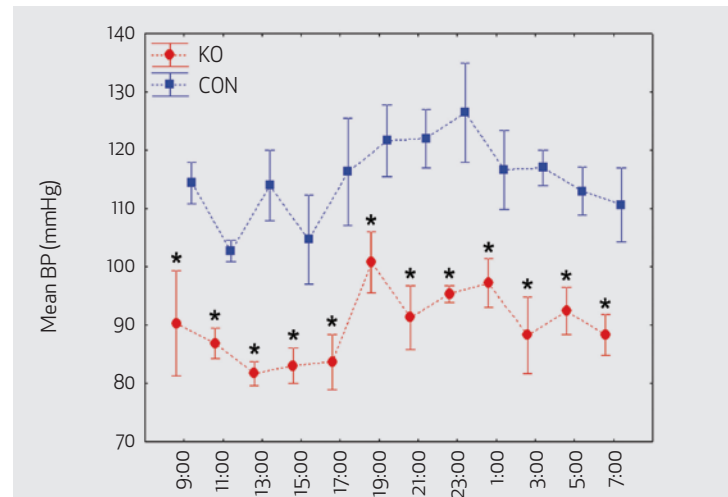
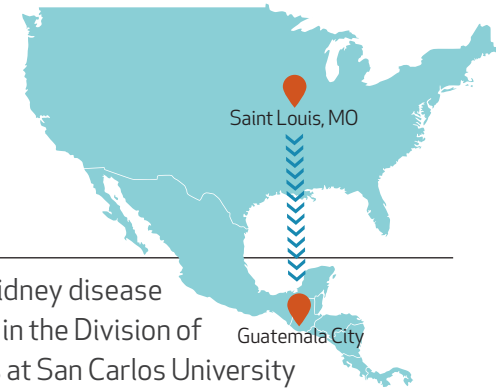
Both the partnership and the educational program were formed as a result of scientific inquiry into a condition called Mesoamerican nephropathy that exists in Guatemala and other countries with a tropical climate. Also known as non-traditional CKD of unknown origin (CKDnT), the disease’s cause is undetermined. However, people with CKD who live in tropical climates share certain characteristics: Most are male, 20 to 30 years old and workers in sugarcane fields situated at sea level, areas subjected to intense heat.

In March 2014, Rothstein and a group of Guatemalan physicians initiated a study of patients with CKD living in coastal Guatemala and receiving renal dialysis. While the exact cause of CKD in these patients remains unknown, Rothstein says the research team uncovered a dialysis complication caused by the use of temporary catheters that

can result in “severe infections, prolonged hospital admissions, disability and premature death. We knew we could help by providing dialysis catheters and training physicians and nurses in tunneling techniques.” He notes that a program is now in place to eliminate this particular complication, “first in Guatemala City, and then, hopefully, throughout the country.”

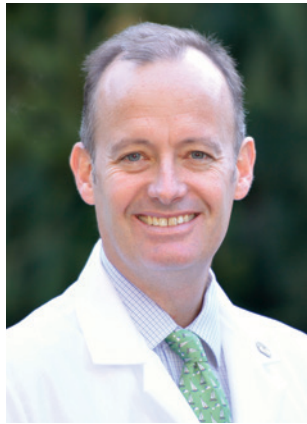
In addition to providing lifesaving equipment and protocols, the partnership has enhanced educational opportunities and skill development. Recently recognized by the International Society of Nephrology (ISN) as an ISN Sister Renal Center, the partnership between U.S. and Guatemalan renal specialists has forged a link that has resulted in ongoing training and innovations in treatment.

— S. FECHTER



Leadership

Division of Nephrology



Benjamin Humphreys, MD, PhD,
Chief, Division of Nephrology

Benjamin Humphreys, MD, PhD, joined the Division of Nephrology as chief on July 1, 2015. A member of the American Society of Clinical Investigation and an Established Investigator of the American Heart Association, his research focuses on understanding the pathogenesis of kidney injury and regeneration. His laboratory combines mouse genetics, adult injury models, genomics and translational approaches—all with the goal of identifying and validating novel therapeutic strategies to treat humans suffering from kidney disease.

▶ Renal division website: renal.wustl.edu

GENERAL NEPHROLOGY

Monica Chang-Panesso, MD
Ying Maggie Chen, MD, PhD
Steven Cheng, MD
Daniel Coyne, MD
James Delmez, MD
Seth Goldberg, MD
George Jarad, MD
Anuja Java, MD
Tingting Li, MD
Brent Miller, MD
Aubrey Morrison, MBBS
Will Ross, MD, MPH
Marcos Rothstein, MD
Eduardo Slatopolsky, MD
Anitha Vijayan, MBBS
David Windus, MD
Timothy Yau, MD

TRANSPLANT NEPHROLOGY

Daniel Brennan, MD, *Director*
Tarek Alhamad, MD, MS
Andrew Malone MB, BCH
Thin Thin Maw, MD, MS
Rowena Delos Santos, MD

NEPHROLOGY RESEARCH

Feng Chen, PhD
Jianghui Hou, PhD
Sanjay Jain, PhD, MD
Moe Mahjoub, PhD
Jeffrey Miner, PhD



Clinical Trials

The following represents some of the investigator-initiated and sponsored clinical trials in the Division of Nephrology at Washington University. These trials are currently active and enrolling subjects.



Daniel Brennan, MD

Effects of Inhibiting Early Inflammation in Kidney Transplant Patients
Daniel Brennan, MD

Choosing Immune Suppression in Renal Transplantation by Efficacy and Morbidity
Daniel Brennan, MD

PROTECT: Prospective Observational Trial to Evaluate the Correlation of T-SPOT® Response to CMV Disease and T-Cell Mediated Acute Graft Rejection
Daniel Brennan, MD



Daniel Coyne, MD

Credence Study: A Randomized, Double-Blind, Event-Driven, Placebo-Controlled, Multicenter Study of the Effects of Canagliflozin on Renal and Cardiovascular Outcomes in Subjects With Type 2 Diabetes Mellitus and Diabetic Nephropathy
Daniel Coyne, MD

A Phase III, Randomized, Double-Blind, Placebo-Controlled Study of the Efficacy and Safety of Roxadustat (FG-4592) for the Treatment of Anemia in Chronic Kidney Disease Patients Not on Dialysis
Daniel Coyne, MD

KD019-101: A Safety, Pharmacokinetic and Dose-Escalation Study of KD019 in Subjects With Autosomal-Dominant Polycystic Kidney Disease
Seth Goldberg, MD

A Phase IIIB, Multicenter, Open-Label Trial to Evaluate the Long-Term Safety of Titrated Immediate-Release Tolvaptan in Subjects With Autosomal-Dominant Polycystic Kidney Disease
Seth Goldberg, MD

ATHENA: A Natural History Study to Observe Disease Progression and Standard of Care, and Investigate Biomarkers in Alport Syndrome Patients
George Jarad, MD

PEXIVAS: Plasma Exchange and Glucocorticoid Dosing in the Treatment of Anti-Neutrophil Cytoplasmic-Antibody-Associated Vasculitis: An International, Randomized, Controlled Trial
Tingting Li, MD

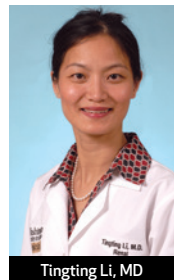
BLISS-LN: A Phase III, Randomized, Double-Blind, Placebo-Controlled Study to Evaluate the Efficacy and Safety of Belimumab Plus Standard-of-Care Versus Placebo Plus Standard-of-Care in Adult Subjects With Active Lupus Nephritis
Tingting Li, MD



Seth Goldberg, MD



George Jarad, MD



Tingting Li, MD

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Innovate

NEPHROLOGY

Barnes-Jewish Hospital has been listed for 23 consecutive years on the U.S. News & World Report elite honor roll of "America's Best Hospitals." It has been the adult teaching hospital for Washington University School of Medicine for more than 100 years.

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