RESEARCH REPORT

Translating Research into Clinical Excellence

2018

Henry Ford Health System®

Dear Colleagues and Friends:

During this past year, Henry Ford Health System embarked on our transformational journey to True North: *"We will be the trusted partner in health, leading the nation in superior care and value."*

Like a compass or map, True North shows us our direction.

Our nationally-recognized research efforts, coupled with medical education, are at the core of the System's academic mission – and critical to successfully achieving our True North.

We are honored to work with the highly talented individuals who conduct research as part of these academic endeavors. These dedicated physicians and bio-scientific staff play — and will continue to play — an important role in the life of our organization.

The scope and quality of our research efforts are reflected in measurements we are proud to share.

From left to right: Drs. Henry Lim, William Conway, and Margot LaPointe

Funding

- Researchers are engaged in more than 2,000 studies;
- Researchers in 2018 were awarded $86 million in grants and contracts from external sources;
- Henry Ford ranked first in non-university based Michigan health systems for funding from the National Institutes of Health (NIH);
- In 2018 Henry Ford Health System:
    - ranked fourth in the state of Michigan in NIH funding; and
    - ranked in the top 20 nationally for independent hospitals receiving NIH funding.

Economic Engine

- Research activities continue to serve as an economic engine for Detroit and Michigan.
- Federal dollars support the local economy.
- Physicians and scientists relocate here from all around the world.
- Our research endeavors support our partnership with Tech Town and Wayne State University.

Leveraging our strengths in clinical innovation and care coordination and implementing new opportunities for academic partnership and facilities will continue to be a System priority.

Our mission is clear: *To improve human life through excellence in the science and art of health care and healing.* Research supports our mission in countless ways. Importantly, translational research and clinical trials enable us to provide the most advanced care, which is of great value to our patients.

We hope you'll enjoy learning more about the breadth and depth of the System's research offerings in the following pages.

Best wishes,

Wright L. Lassiter III
President and Chief Executive Officer
Henry Ford Health System

William A. Conway, M.D.
EVP, Henry Ford Health System
CEO, Henry Ford Medical Group

Margot C. LaPointe, Ph.D.
Vice President of Research

Henry W. Lim, M.D.
Senior Vice President for Academic Affairs

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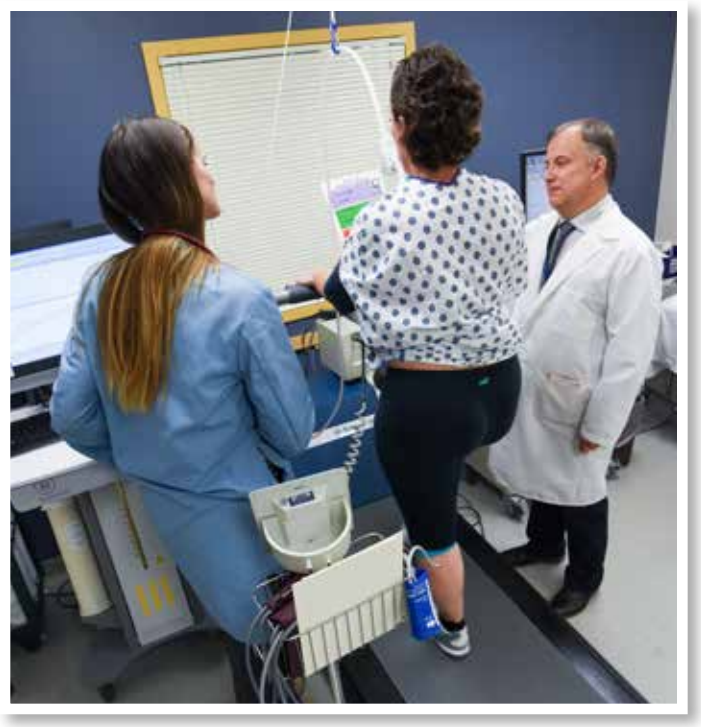
RESEARCH HIGHLIGHTS



Henry Ford Health System's mission is to improve human life through excellence in the science and art of health care and healing. This mission is strongly supported and enhanced by the dedicated staff pursuing scientific activities. Researchers at Henry Ford Health System are engaged in more than 2000 active clinical, public health and basic science studies. Research is strongly supported by leadership and conducted by teams of dedicated and accomplished physicians, scientists and research professionals. Henry Ford Health System's research program is the largest, most well-funded and successful of all non-university health systems in Michigan. In 2018, Henry Ford ranked #182 of more than 2500 institutions receiving National Institutes of Health (NIH) funding from the United States government. The System received more than $86 million in externally-awarded grants, contracts and sub-contracts, $45 million of which was awarded by federal agencies, including the NIH.

Henry Ford Hospital, located in Detroit, is the major academic and research center of Henry Ford Health System. Since 1915, the research professionals at Henry Ford Hospital have focused their efforts on understanding the mechanisms of disease. Their research has led to the development of new, viable treatment options, enhancing and prolonging the lives of people worldwide. Much of the research conducted at Henry Ford Hospital is translational in nature, spanning from bench to bedside. A team of 82 bioscientific staff performs studies that range from whole-animal physiology to cell and molecular biology to bioengineering to image analysis. Research also emphasizes studies that can directly improve patient care. Research teams from the Department of Public Health Sciences and the Center for Health Policy and Health Services Research collaborate with members of the Henry Ford Medical Group as well as researchers in other states to enhance the quality of health care nationwide. Henry Ford physicians also participate in and lead many clinical trials that determine how to best treat disease. At the basic science level, HF Research is focused on:

- Cardiovascular and Renal Research (e.g. high blood pressure, renal function and heart failure)
- Neurosciences Research (e.g. stroke, traumatic brain injury and brain tumors)
- Bone and Joint Research (e.g. osteoarthritis, bone biology and biomechanics and joint motion)
- Cancer Research (e.g. prostate, breast, ovarian, head and neck cancers)
- Immunology Research (e.g. autoimmune and skin diseases, immune basis of cancer)
- Population, Health and Healthcare Research

RESEARCH FUNDING

Research at Henry Ford Hospital is funded by a number of sources. In addition to the National Institutes of Health (NIH), funding is received from the Centers for Disease Control and Prevention (CDC); Department of Defense; NASA; numerous foundations, state and local agencies; and the pharmaceutical and medical device industries.

Henry Ford's research enterprise ranks in the top ten percent of all institutions receiving NIH funding from the federal government. When compared to the research programs of Michigan institutions, it ranks fourth in funding, after the University of Michigan, Wayne State University and Michigan State University. In addition to external funding, the health system supports its research enterprise through its Foundation Endowment.

For more information on any of these subjects, please contact Henry Ford's Vice President for Research, Margot C. LaPointe, Ph.D. at mlapoin1@hfhs.org. Annual research reports, including external funding and peer-reviewed publications, can be found at www.henryford.com. Scroll to the bottom of the home page and click on Research (www.henryford.com/hcp/research). On the Research page, scroll to the bottom and click on the Research Annual Report.

Nancy Hay, administrative director of Research Administration (far left), meets with her staff.

POPULATION, HEALTH, HEALTHCARE AND OUTCOMES RESEARCH PROGRAMS

Christine Johnson PhD (third from left) and Brain Ahmedani PhD (4th from left), lead a discussion on patient recruitment for the All of Us Program.

DEPARTMENT OF PUBLIC HEALTH SCIENCES

The Department of Public Health Sciences (PHS) has a multi-faceted role at Henry Ford, leading or co-leading a number of large externally funded research programs and serving as full collaborators in others. Many projects are national in scope. Additionally PHS faculty and staff invest a substantial effort in medical education, working with trainees and their mentors in the development and conduct of research projects. PHS work also extends into the HFHS administrative and operations world, for example, coordinating and analyzing quality-related projects and training and placing patient advisors on numerous System committees. PHS has continued to grow since its establishment in 1983 and is now the largest federally funded research program in Henry Ford Health System (HFHS). Below we highlight several of our main programs.

Precision Medicine

PHS is heavily engaged in Precision Medicine—an approach to prevention and treatment that takes into account an individual's genetic susceptibility, personal physiology and metabolism, environmental exposures and personal preferences. One of PHS's newest NIH-funded projects is leading a consortium of health provider organizations within the All of Us Cohort Program, part of the NIH Precision Medicine Initiative. HFHS and their consortium members Baylor Scott and White Health System and Spectrum Health, will collectively enroll 10,000 participants during the first year of funding. According to the NIH web site, "Information from the program will be a broad, powerful resource for researchers working on a variety of important health questions. Importantly, the program will focus not just on disease, but also on ways to increase an individual's chances of remaining healthy throughout life." Precision Medicine research and application requires cutting edge expertise related to the collection, management and analyses of "Big Data". The Center for Bioinformatics is composed of bioinformaticians, biostatisticians, and an epidemiologist with expertise in design, analysis, and interpretation of studies involving high-dimensional bio-molecular profiling data. The analytical team has extensive experience in all areas of "-omics" data analysis and interpretation, including ongoing studies involving array- and sequence-based profiling of germline and somatic DNA variation, DNA methylation,

mRNA, micro-RNA, proteins, metabolites, and metagenomics. Current projects include conditions as disparate as asthma, allergic outcomes, lung cancer, chronic obstructive pulmonary disease, prostate cancer, head and neck cancer, breast cancer, ovarian cancer, multiple sclerosis, Parkinson's disease, and human immunodeficiency virus. In 2016, PHS Bioinformatics Center members submitted 26 grants as either co-investigator or principal (five of these grants were funded) investigator and collaborated or led on 15 published manuscripts.

Finally, Patient Centered Outcomes Research is a different approach to research that compels investigators to engage with patients, caregivers and other stakeholders in the course of studies and focus on questions and outcomes that matter to them. Henry Ford's Patient Engaged Research Center was developed through an AHRQ grant. Affiliated investigator teams have secured multiple awards from the Patient Centered Outcomes Research Institute (PCORI).

Health Disparities

Despite the great strides made in disease prevention and treatment, public health challenges remain and significant racial and ethnic disparities persist. HFHS has pooled resources and expertise from a multidisciplinary team of outstanding individuals to address such disparities and includes this research domain in almost all projects. The HFHS Health Disparities Research Collaborative sits in the Department of Public Health Sciences, and provides a mechanism for the support and collaboration of investigators working to understand racial and ethnic health disparities. Examples of such research projects include:

1) Racial disparities in poor birth outcomes and higher risk of allergic disease and asthma, with children born to African-American mothers having a higher risk;
2) Racial disparities in death rates for asthma for African American adolescents aged 15-19 years than for White adolescents and for younger children and studies on disease management technology-based interventions for high risk youth;
3) Studies on sexual and gender minority (SGM) youth to understand correlations between SGM status and depression, suicide attempts, bullying, illicit drug use, and increased rates of HIV (Focus on the Rainbow program);
4) Racial disparities in the development of uterine fibroids with a focus on how vitamin D, reproductive tract infections and ancestry informative markers are related to development of fibroids in African American women.
5) Racial disparities in the development and severity of the autoimmune disease sarcoidosis, which preferentially impacts more African Americans;
6) Investigating why African Americans have a higher incidence rate and severity of prostate cancer compared to European Americans.

Health Care Systems Research Network

HFHS is one of the charter member organizations of the Health Care Systems Research Network (HCSRN). Twenty health plans and integrated delivery systems from across the nation (and globally) form the infrastructure for research collaboration. One of the key innovations of the HCSRN is the creation and maintenance of the Virtual Data Warehouse (VDW). PHS has taken the lead in the creation and maintenance of the VDW at Henry Ford. Health care and population data from local sources are transformed into a common data model, greatly improving the efficiency of multi-center research projects. Major areas of focus include cancer (Cancer Research Network, or CRN) and cardiovascular disease (Cardiovascular Disease Research Network, or CVRN) but studies have ranged from rare to common diseases, and health and disease across the life course.

The CRN currently includes 9 participating institutions. Combined, these organizations provide health care for close to 9 million health system members. Recent and ongoing CRN studies led by scientists in PHS include: Statins & lymphoid malignancy risk, Encouraging adults to make effective nutrition choices, and the Impact of the US Preventive Services Task Force recommendation to stop wide-spread use of PSA screening on PSA surveillance after a diagnosis of cancer.

Similarly, HFHS, led by PHS faculty, was one of the founding members of the CVRN, which began in 2007. PHS has participated in several CVRN studies. In the Longitudinal Study of Implantable Cardioverter Defibrillators (ICD), HFHS along with six other HCSRN sites combined data from the VDW, ICD therapy data available from the EMR, and the National Cardiovascular Data Registry to identify risk factors for appropriate and inappropriate ICD therapy (shocks and pacing). HFHS was also one of 15 HCSRN sites nationally to participate in the Cardiovascular Disease Surveillance Study, which examined the incidence of major cardiovascular disease outcomes

(myocardial infarction, stroke and heart failure); this was a first step towards public health need for a nationwide cardiovascular disease surveillance program.

The Chronic Hepatitis Cohort Study (CHeCS) comprises four clinical sites, all members of the HCSRN. PHS directs the data coordinating center and HFHS is a clinical site. CHeCS is the first comprehensive longitudinal cohort study of viral hepatitis in the US, with over 20,000 patients. Since 2010, CHeCS—funded by the CDC Foundation, the Centers for Disease Control and Prevention, and Gilead Sciences—has produced almost three dozen scientific publications.

The Fibrotic Liver Disease Consortium (FOLD) is the first large-scale longitudinal cohort study of primary biliary cholangitis, an autoimmune disease that can result in liver damage, cirrhosis, and death. With PHS as a clinical site and data coordinating center, FOLD comprises 11 clinical sites from the HCSRN, with access to data from over 14 million adult patients. Funding by Intercept Pharmaceuticals commenced in 2016 and FOLD has one manuscript under review.
PHS is the lead in the MENU GenY Study-Encouraging Young Adults to Make Effective Nutrition Choices. This R01 study is an online, randomized intervention study with aims to improve dietary intake for young adults, focusing on fruits and vegetables.

Members of PHS are active participants in the HCSRN Patient Engagement in Research (PER) Special Interest Group. The aim of the PER is to help member research organizations build infrastructure for patient engagement in research, and to develop generalizable tools to enhance engagement efforts.

Cancer

PHS is home to the Cancer Epidemiology Prevention and Control Program (CEPC) of the Henry Ford Cancer Institute (HFCI). Although CEPC includes investigators from over ten departments at HFHS, most CEPC investigators' primary appointments are within PHS. Key areas of ongoing research include prostate, brain, and lung cancer.

PHS prostate cancer research highlights the emerging field of molecular environmental pathological epidemiology which is a combination of epidemiology, environmental science and pathology. Investigators have ongoing NIH and Department of Defense (DoD) funding to study a variety of changes measured directly in prostate tissue that lead to the development and progression of prostate cancer. PHS investigators, working closely with the Department of Pathology and national collaborators, are measuring environmental exposures of compounds that bind to DNA molecules, DNA adducts, as prostate cancer biomarkers that increase risk of disease susceptibility and/or progression. Inflammatory biomarkers are also being measured in pre-malignant prostate tissue to better quantify on a molecular level the key indicators of an inflammatory response that promotes prostate carcinogenesis. In an NIEHS funded R21, PHS investigators are studying metal levels in prostate cancer and adjacent normal tissue to better understand the role of cadmium and the androgen receptor in prostate cancer progression and in race disparities in the disease. Through DoD funding, a PHS team is studying both tumor DNA copy number and methylation alteration profiling to identify biomarkers associated with biochemically recurrent disease in African Americans. These projects are leading to new insights regarding the differences and similarities in prostate cancer in African American and white men.

PHS CEPC Cancer Researchers Collaborate with other HFCI Programs and with National Cancer Programs. PHS biostatisticians work with HF researchers in the Neuro-Oncology Program and multi-national brain tumor consortium(Glioma Longitudinal AnalySIS, GLASS) to help identify molecularly homogeneous subgroups of central nervous system cancers. The biostatistical role is to connect the proposed molecular subgroups to patient characteristics and clinical outcomes, thus beginning the translation to the clinic. Understanding the diversity of disease helps the neuro-surgery research teams better design patient-specific treatment plans.

PHS epidemiologists are embedded within the HFCI Thoracic Oncology Program. Together with the Departments of Pulmonary and Critical Care Medicine and Radiology, PHS is establishing a lung cancer screening tracking system to support clinical and research needs related to low dose CT (LDCT) use for lung screening and to monitor smoking cessation among the HFHS general and cancer survivor populations. This is an extension of PHS' previous work on the National Lung Screening Trial which led the US Preventive Services Task Force to recommend LDCT for lung cancer screening. The program is also working toward precision lung cancer screening for all patients but in particular African Americans, known to have higher risk of lung cancer among moderate smokers when compared to whites.

As one of the ten sites conducting the Prostate, Lung, Colorectal and Ovarian Cancer Screening Trial, PHS continues involvement in the long-term follow-up of over 24,000 participants which were enrolled at HFHS. This landmark trial informed clinical decision-making and continues to advance the science regarding reducing morbidity and mortality from cancer.

Developmental Origins of Disease

An area of great interest amongst PHS investigators is the study of the early life developmental origins of health and disease (DOHaD). HFHS was the site of the founding of the US-DOHaD Society in 2016. The epidemiologists in PHS are working to understand how the prenatal experience and placental health relate to immune and metabolic development and subsequent respiratory health. Three PHS birth cohort studies, the Childhood Allergy Study (CAS), the Wayne County Health Environment Allergy and Asthma Longitudinal Study (WHEALS), and the Microbiota, Allergy, Asthma & Pets (MAAP) birth cohorts, which were developed with NIH and foundation funds, have facilitated the work of PHS investigators. PHS investigators lead an NIH Program Project program that focuses on the effects of the home environmental microbiota and infant gut microbiota on childhood health. These investigators are also working with other scientists from across the country on the NIH Environmental Influences on Child Health Outcomes (ECHO) Program which seeks to pool 50,000 children enrolled in cohort studies in the Unites States to further identify early life factors related to subsequent health.

Medical Education Research

PHS has a commitment to training our clinical colleagues in research, both to utilize published findings to drive evidence based medicine and to fill knowledge gaps in care through their own studies. We provide educational opportunities and support for clinicians at all levels of their careers, from residents to fellows to senior staff. Many of our programs are also applicable to other clinical and non-clinical research staff. This research is facilitated by our Population Data Management and Biostatistics Cores.

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Major clinical partners in PHS studies include Drs. Edward Zoratti, Haejin Kim and Rachel Kado of Allergy and Clinical Immunology; Drs. Maureen Connelly (PHS Clinical Scholar), Stacey Leatherwood and Charles Barone of Pediatrics; Dr. Stuart Gordon of Gastroenterology; Dr. Roopina Sanga of Womens Health; Drs. Anupama Nair, David Willens and Keoki Williams, Internal Medicine; Dr. Martina Caldwell (PHS Clinical Scholar) of Emergency Medicine; Dr. Nikki Pritchett of Dermatology; Dr. Erik Makni in Orthopedics; Dr. Kelly Collins in Transplant Medicine; Dr. David Lanfear of Cardiology; Drs. Peter Lewitt and Mirela Cerghet of Neurology; Dr. Chris Drake of Sleep Medicine; Dr. Kausik Umanath of Nephrology; Dr. Ilan Rubinfeld in Surgery; and Dr. Norman Markowitz of Infectious Disease. In addition, there are numerous collaborators related to cancer population studies: Dr. Nilesh Gupta, Dhananjay Chitale and Sean Williamson of Pathology; Drs. Lisa Newman and David Nathanson of Surgery; Dr. Craig Rogers of Urology; Dr. Steven Chang of ENT; Dr. Mike Simoff of Pulmonary; Dr. Clara Hwang of Hematology/Oncology; and Drs. Steve Kalkanis, Tobias Walbert and Ian Lee in Neurosurgery.

Center for Health Policy and Health Services Research (CHPHSR)

Health Policy

CHPHSR is the focal point within the Henry Ford Health System for state and federal policy analysis and for coordinatiNG the System's participation in state and federal health policy demonstration projects. Staff in CHPHSR read and provide summaries of federal and state legislation and regulation, and manage the process of writing comment letters on proposed regulations to federal agencies. CHPHSR also supports System applications to participate in demonstration projects (for example, the Next Generation ACO and the Oncology Care Model demonstrations), with an analysis and "clearinghouse" function prior to the process of writing applications in order to determine which programs to apply for and which departments or business units within HFHS will be in a lead role.

CHPHSR staff serve on several federal and state advisory commissions, expert panels, review committees, and work groups in areas like Medicare payment, quality measurement, and "health care delivery innovation".

Brian Ahmedani PhD, HPHSR Center Director (far left), engages with staff on new research ideas.

Staff in CHPHSR also conduct policy-relevant research that is published in peer-reviewed journals. Recent papers have addressed the issue of effects of patient-level or community-level socioeconomic status on performance measures used in pay-for-performance programs, and have contributed to an ongoing national debate on whether such measures should be statistically adjusted for SES factors. Another set of analyses has addressed questions about the underlying conceptual and empirical foundation for global ratings of hospital quality – specifically the question of "is there really such a thing as overall hospital quality?"

Health Services Research

A variety of health services research programs are housed within CHPHSR. These include funded projects in precision medicine, decision sciences, medication adherence, technology-based interventions, outcomes research, psychiatry, human genetics, and pharmacogenomics.

CHPHSR investigators used direct observation and audio-recordings from more than 500 primary care patient-physician interactions to study how colorectal cancer screening and other clinical preventive services were discussed during annual check-ups, and are now currently developing and testing a patient portal tool (e-Assist) for engaging and supporting primary care patients to make decisions about and to obtain colorectal cancer screening. Capitalizing on the unique and comprehensive data collected thus far in the screening study, Henry Ford recently received funding from the National Institute of Mental Health (NIMH) to use the data to study how patients' mental health concerns are being addressed by primary care physicians.

Henry Ford is one of the participating members of both the NIMH-funded Mental Health Research Network and the NIDA-funded Health Systems Node of the National Drug Abuse Treatment Clinical Trials Network. Investigators in both CHPHSR and in Behavioral Health Services/Psychiatry at Henry Ford are involved in a series of trials, prospective studies, and observational projects in the areas of mental health and substance use disorders. Henry Ford is also a recognized national leader in suicide prevention research.

Many of the studies in CHPHSR include attention to issues of racial/ethnic disparities in health care or outcomes of health care. For example, asthma-related hospitalizations, emergency room visits and deaths are three to five times higher among African-American patients than white patients. Regular inhaled

corticosteroid (ICS) use is the cornerstone treatment of uncontrolled asthma. Investigators are assembling a diverse patient population from metropolitan Detroit to identify genes and genetic markers associated with ICS treatment response and to determine whether these predictors differ among groups.

African Americans also have a higher prevalence of and mortality due to heart failure than whites. Beta-blockers are the foundation of modern care for heart failure, but Henry Ford researchers have shown that beta blocker treatment is much less protective among African Americans than whites. The team is now leading an NIH-funded study that will enroll 1,000 heart failure patients in a registry to quantify medication exposure and clinical outcomes to improved targeting of therapy to those with the highest likelihood of favorable response.

The Center also has a significant national and international presence in studies pertaining to genetics of complex traits and chronic diseases. Notably, the Study of Asthma Phenotypes and Pharmacogenomic Interactions by Race-Ethnicity (SAPPHIRE) is one of the largest prospective cohort studies of asthma in the world. This cohort study has contributed to our knowledge of the genetics of asthma, as well as other traits and conditions, such as medication response, lung function, eczema, environmental allergies, and obesity. These findings have resulted in multiple publications in leading medical journals, such as the New England Journal of Medicine and Nature Genetics.

For myriad subpopulations, access to quality health care remains a significant obstacle. In recent years, technology-based interventions have begun to bridge this gap, alleviating physical and psychiatric problems for some and providing a catalyst for traditional treatment for others. To this end, investigators at CHPHSR are utilizing computer- and mobile phone-based interventions to reduce health disparities among a number of vulnerable populations, including youth exiting the foster care system, suicidal teens, and adolescents with comorbid mental health and substance use issues.

CHPHSR is the administrative home for a large national cohort study of hepatitis. The Chronic Hepatitis B & C Cohort Study (CHeCS) is the first comprehensive U.S. longitudinal observational, non-VA cohort of 13,000 or more patients with chronic viral hepatitis B and C. The cohort was established in 2009 order to improve the understanding of chronic viral hepatitis and the impact of screening, care, and treatment recommendations in the United States. The study was originally funded by CDC Foundation in cooperation with the CDC Division of Viral Hepatitis, and is presently funded with grants from the U.S. Centers for Disease Control and Gilead Sciences. Henry Ford Health System, via a collaborative effort between CHPHSR, the Division of Gastroenterology/ Hepatology, and the HFHS Public Health Sciences department, serves as the lead site and data coordinating center for this multicenter study. Among recent findings – that hepatitis C patients who fail interferon-based therapy have increased risk of hepatocellular cancer compared to untreated patients after controlling for stage of liver disease; also that compared to a general population, patients with chronic hepatitis C have significantly higher overall risk of cancers of the liver, pancreas, rectum, kidney, lung, and non-Hodgkin lymphoma, and that these cancers are diagnosed at a significantly younger age. The study is currently investigating the uptake and effectiveness of new, highly effective antiviral therapy for hepatitis C, as well as the natural history of hepatitis B and the impact of antiviral therapy.

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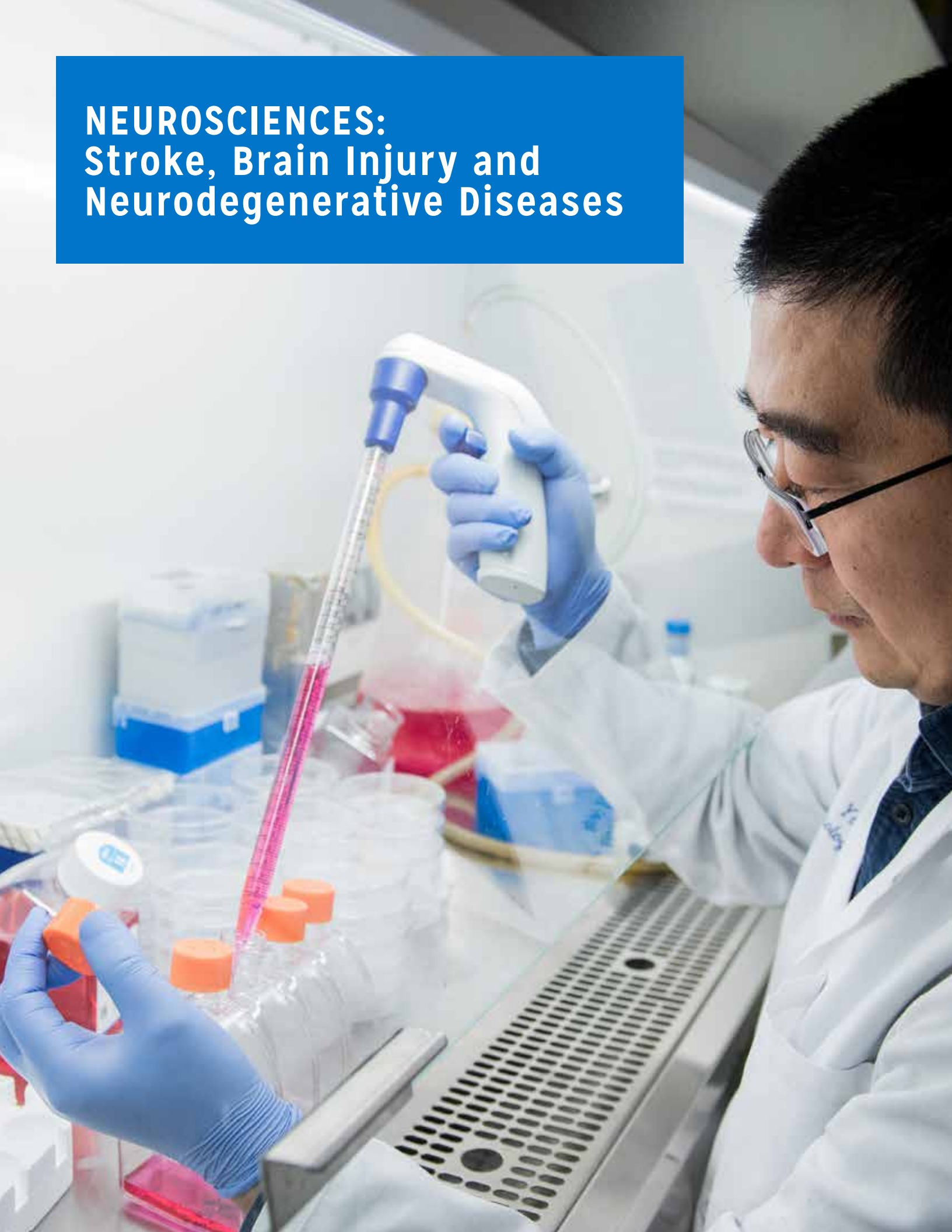
NEUROSCIENCES: Stroke, Brain Injury and Neurodegenerative Diseases



Almost 800,000 Americans are diagnosed with stroke each year, and approximately one-third of them die. Health care costs for stroke exceed $60 billion per year. The Henry Ford Department of Neurology is internationally acclaimed for its research in stroke and neural injury and is the major driving force in the development of restorative neurology. The department has pioneered research in restorative therapy for the treatment of stroke, traumatic brain injury, peripheral neuropathy and neurodegenerative diseases using both cell-based and pharmacologic therapies, and has now again pioneered the use of exosomes, nanoparticle containers released by many cells, for the restorative treatment of neurological injury, and disease. The goal is to remodel the central nervous system (CNS) to compensate for the injured brain tissue. Researchers have also made major contributions to the development of neuroprototective agents, such as tissue plasminogen activator (tPA), and have been major innovators in the development and use of magnetic resonance imaging (MRI) for understanding neurological disease.

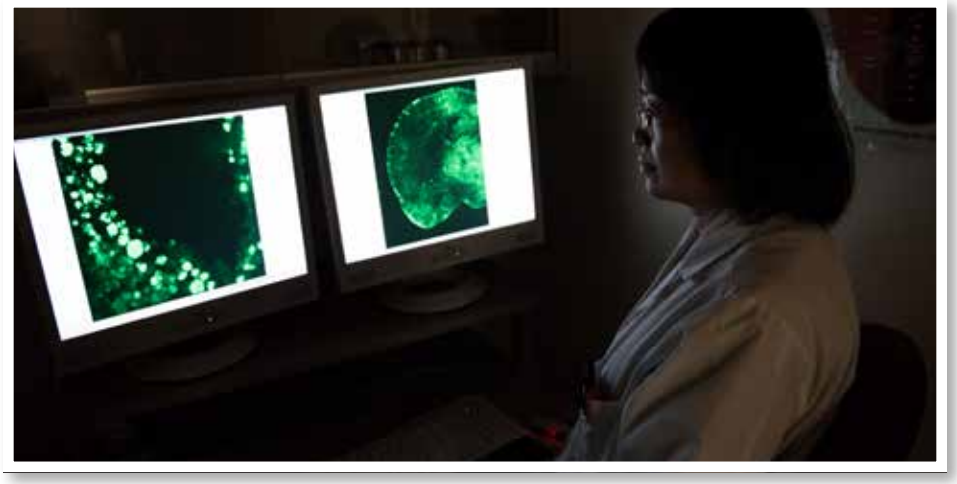
The Chopp Lab, the largest basic science lab in the Neurology Department, focuses their research efforts on stroke, peripheral neuropathy, cognitive dysfunction, and use of exosomes in treatment of these diseases.

Department of Neurology research has shown that administration of exogenous cells, such as bone marrow mesenchymal cells, cord blood, cord tissue, placental tissue, brain progenitor cells and adult stem cells derived from various organs, greatly improves neurologic outcome after stroke and neural injury. Driving this functional improvement is the remodeling of the CNS, including the generation of new brain cells (neurogenesis), formation of new blood vessels (angiogenesis), and creation of new electrical connections (synaptogenesis). Several pharmacologic agents also have the capacity to enhance recovery from brain injury and may restructure the injured CNS. These include erythropoietin, carbamylated erythropoietin, statins, nitric oxide donors, thymosin-**β**, agents that increase cGMP such as sildenafil and tadalafil, and agents that increase high-density lipoproteins such as niacin and Niaspan. Many of these agents are being tested in clinical trials and show promise for future therapy. In major new work, our department has demonstrated that exosomes mediate the therapeutic efficacy of stem cell therapy for the treatment of disease and injury. We have therefore employed exosomes from a variety of cells, as well as "designer" exosomes in which the microRNA content (regulates genetic translation) are modified for the efficacious treatment of neurological disease and injury, as well as for the treatment of certain cancers. This novel therapeutic approach has the potential to greatly impact patient care.

The department's work in restorative neurology has spawned fundamental research into the mechanism by which cells or drugs induce brain plasticity. Researchers have published extensively on the molecular mechanisms controlling the generation of new brain cells and blood vessels. In addition, the coupling of neurogenesis and angiogenesis has been studied, demonstrating that restorative therapy establishes a remodeling microenvironment within the compromised tissue that stimulates structural changes and rewiring to compensate for injury. Moreover, this research has demonstrated that after injury to the brain, rewiring and other dramatic changes occur in the spinal cord and the contralateral brain hemisphere. The degree of rewiring strongly correlates with recovery of function, and treatments that stimulate functional recovery also lead to rewiring of the spinal cord and the contralateral hemisphere. Insight gained from stroke models is now being extended to studies of traumatic brain injury, multiple sclerosis and diabetes-induced peripheral neuropathy.

Researchers have recently started to focus on the diabetic brain. Diabetes is a major risk factor for stroke, and diabetic patients have more severe stroke and poor outcomes. The laboratory is investigating the bases for these adverse effects of diabetes on stroke and is actively developing new therapies to treat the diabetic stroke brain. In addition, we have a strong emphasis on how diabetes affects cognitive function, particularly during aging. We have therefore developed novel ways to predict cognitive impairment and have demonstrated that MRI of the glymphatic system (brain "waste" removal system can identify and predict cognitive and learning dysfunction. This technology is presently being applied to a variety of neural injury in our laboratory.

The Henry Ford Neurology research laboratory has initiated a major effort into investigating the role of microRNAs (miRNA) and epigenetics in neurological disease and recovery. Results show that miRNAs regulate apoptosis (cell death) and stimulate brain plasticity and neurogenesis. This pioneering work may have a major impact on the treatment of



many neurological diseases. The research on miRNAs has also greatly impacted our pioneering work on the therapeutic role of exosomes in the treatment of disease. Our department was also the first to demonstrate the importance of miRNA in how tumors alter their microenvironment to promote cancer. We are actively employing exosomes and miRNA as monotherapy or in combination for the treatment of multiple cancers.

For more than 25 years Henry Ford neurologists have used magnetic resonance imaging (MRI) for understanding neurological disease. Researchers have developed novel approaches to the MRI measurement of brain plasticity, including angiogenesis and restructuring of white matter in the injured brain, which appears to play a pivotal role in functional recovery. Techniques have been developed to measure new vessels, vessel density and white-matter structure in human and animal brains. This has the potential to create new diagnostic and prognostic tools for management of neurological disease, so that MRI will greatly augment efforts in restorative neurology.

Neurology researchers maintain a highly productive research effort on developing neuroprotective agents, with a focus on the treatment of the elderly brain. Agents have been identified that act synergistically with tPA to greatly extend its therapeutic window, enhance its efficacy and reduce adverse effects.

The multiple sclerosis (MS) research lab is focused on understanding the role of metabolic derangement in this and other neurological diseases.

This laboratory has comprehensively shown the ameliorating role of AMPK (adenosine monophosphate activated kinase), a master regulator of metabolism, in the pathogenesis of MS using preclinical mouse models and its potential as a therapeutic target. While studying the role of AMPK in MS pathobiology, our laboratory was intrigued by the metabolism of the disease itself, which led us to investigate how the metabolism would be altered by MS disease progression. Using cutting edge technologies in the field of metabolism, we identified blood based multiple metabolic pathways in MS patients, that can be used to monitor MS progression and response to therapy. Additionally, we are currently testing the therapeutic targeting of these metabolic pathways in various MS mouse models. We believe that our approach of bed to bench and back to bed for translational purposes will not only provide a better understanding of the etiopathogenesis of MS, but will also allow for development of novel therapeutic modalities to cure this disease.

To achieve our goal, we are working on three major interconnected themes: 1) to understand the role of metabolic derangement in MS using preclinical mouse models and MS patients; 2) to identify biofluids based predictive metabolic biomarkers that can aid in monitoring and therapeutic response of MS patients and 3) defining the role of AMPK (adenosine monophosphate activated kinase), a master regulator of metabolism, in the pathogenesis of EAE/MS and its potential as a therapeutic target.

A relatively new neurology research program involves the discipline of nanomedicine and drug delivery with noninvasive molecular imaging.

Nanomedicine, carrying therapeutic payloads and delivered within close proximity of the tumor, can be designed to play a significant role in increasing treatment effectiveness while decreasing severity of side effects. Specifically, this lab work focuses on developing small-sized nanoparticles that can cross tumor blood brain barrier and target primary glioblastoma multiform (GBM) selectively. This work has been aided by the development of a series of new dendrimer-based multifunctional

nanoparticles that are detected by standard MR relativity methods or new MRI methods based on Paramagnetic Chemical Exchange Saturation Transfer (PARACEST). With the development of small nano-sized molecular imaging agents that can target GBM selectively, primary GBM tumor selective drug delivery and imaging can be accomplished by using these dendrimer-based nanoparticles that possess long blood half-lives. We have reformulated promising anti-cancer drugs that failed to reach clinical trials, or failed in clinical trials due to toxicity or poor bioavailability. These reformulations have reproduced usable, safe therapies using nanoparticles. We have also used state-of-the-art MRI methods to study tumor progression and the early responses to chemotherapies in pre-clinical animal models.

The department has a successful track record for obtaining NIH R01, R21, R43, R44, SBIR and STTR research grants, NIH program project grants and funding from other agencies and foundations. The work of researchers is shared in numerous annual publications.

Department of Neurosurgery scientists and physician-scientists, in conjunction with Department of Neurology collaborators, work together in epilepsy, traumatic brain injury, brain hemorrhage, spinal surgery, aneurysms and hydrocephalus research.

Henry Ford Comprehensive epilepsy program is pleased to be part of a national, multi-center clinical trial for the treatment of mesial temporal lobe epilepsy (mTLE). The SLATE (stereotactic laser ablation for temporal lobe epilepsy) clinical trial seems to comprehensively evaluate the use of minimally-invasive laser ablation to precisely destroy specific, deep structures within the temporal lobe which cause epilepsy. This trial, sponsored by Medtronic, Inc., will use the Visualase™ MRI-Guided Laser Ablation System which is an FDA-approved device for thermal ablation within the brain. The Department of Neurosurgery already has extensive experience using the Visualase system for both the treatment of epilepsy as well as for brain tumors. This procedure provides an alternative to the traditional surgery for temporal lobe epilepsy, requires only a small incision, and is well tolerated by patients, who typically go home the day following the procedure.

Traumatic brain injury (TBI) continues to be a cause of human morbidity. No therapeutic intervention yet exists to repair neuronal damage. Treatment consists of evacuating mass lesions and providing an optimal environment for the brain to recover. Investigators are examining the efficacy of transplanting marrow stromal cells (MSCs) in a model of head trauma. If this approach improves functional outcome, a new range of therapeutic interventions will be possible. To enhance the effect of MSCs, the cells are also being transplanted after being injected into collagen scaffolds. These provide a platform that bridges the gap in the damaged brain and enables MSCs to exercise their neurorestorative capabilities, combining bioengineering techniques with cell therapy to repair neural injury. In addition to using entire cells we are using exosomes derived from MSCs to promote neuroplasticity in young adult male rats subjected to TBI induced by controlled cortical impact. The exosomes transfer RNAs and proteins to other cells which then act epigenetically to alter the function of the recipient cells. The development of cell-free exosomes derived from MSCs for treatment of TBI is promising. A better understanding of the effects of exosomes derived from MSCs on functional recovery and brain remodeling and the underlying mechanisms of their actions are prerequisite for the development of MSC exosomes as an efficacious and novel therapy for TBI.

The department is also using pharmaceutical agents such as statins and velcade to promote neural recovery and improve functional outcome after TBI. In addition to their lipid-lowering effect, statins have demonstrated neuroprotective and neurorestorative capabilities that can be used to treat TBI. MSCs and statins have been combined to assess any synergistic effect. Department researchers are conducting a pilot clinical study to treat TBI with statins.

The Cerebrovascular Laboratory in the Department of Neurosurgery is studying the effects of mesenchymal stromal cell-derived exosomes as a potential treatment for intracerebral hemorrhage (ICH). We have shown that exosome administration after experimental ICH promotes angiogenesis and neurogenesis while improving functional recovery. In clinical practice we are participating in a multisite randomized study (MISTIE) of administering tPA directly into the intracerebral clot after ICH, to determine if this promotes clot resolution and improves clinical outcome.

Neurology Clinical Research and Clinical Trials

The Department of Neurology actively conducts and supports clinical trials for a wide spectrum of neurological disorders encompassing research phases I, II, III and IV. The clinical trial programs are funded by various sources such as the NIH, foundations and industry sponsors, or are initiated by department investigators and funded by the NIH, industry sponsors and philanthropic donations.

As leaders in the field of cerebrovascular treatment and neurocritical care, Henry Ford's cerebrovascular team participates in both sponsored and physician initiated studies. The team includes stroke neurologists, cerebrovascular neurosurgeons, neuroendovascular specialists and neurointensivists. Research studies include treatment for acute ischemic stroke, chronic ischemic stroke, intracerebral hemorrhage, subarachnoid hemorrhage and coagulation reversal in intracranial bleeds.

Epilepsy research at Henry Ford includes laboratory studies and clinical trials of drug therapies that reduce the incidence and intensity of seizures with fewer side effects; new technology that improves the complex diagnostic process to pinpoint the source of the electrical misfiring in the brain; and innovative techniques, such as neurostimulation devices, that help patients whose seizures are not controlled with medication and who cannot undergo surgery.

The Parkinson's Disease and Movement Disorders Center at Henry Ford has three decades of experience in the medical and surgical management of Parkinson's

Disease, essential tremor, dystonia, ataxia and other neurologic disorders that affect normal movement of the body. Clinical trials offered by the Parkinson's Disease and Movement Disorders Center have included development of new medications and the first successful gene therapy clinical trial for Parkinson's Disease. The Center has participated in academic consortia for investigating neuroprotective treatments, improve rating scales and symptomatic therapies for tremor and dystonia in addition to Parkinson's Disease research.

Henry Ford Neurology programs for neurodegenerative, neuromuscular and neuroimmunologic diseases are currently participating in studies for treatment of amyotrophic lateral sclerosis (ALS), multiple sclerosis (MS), neuromyelitis optic/neuromyelitis optica spectrums disorder (NMO/NMOSD) and dementia. The MS clinic has participated in recent landmark studies for oral treatments of disease modifying therapies as well as the first treatment for primary progressive multiple sclerosis.

Henry Ford has 1 of 29 magnetoencephalography (MEG) brain imaging systems in the country. In addition to studies with epilepsy patients, physicians and neurology scientists are also using the MEG to explore dyslexia, language processing, tinnitus, sensory gating in schizophrenia and generalized dystonia.

Our speech and language pathologists are working on several projects that include determining the effects of deep brain stimulation frequency on swallowing in individuals with Parkinson's Disease as well as self-perception of dysphagia and vocal handicap in Parkinson's Disease. More recent research currently in the planning stages will focus on testing of novel electrostimulation devices to improve swallowing disorders after brain injury.

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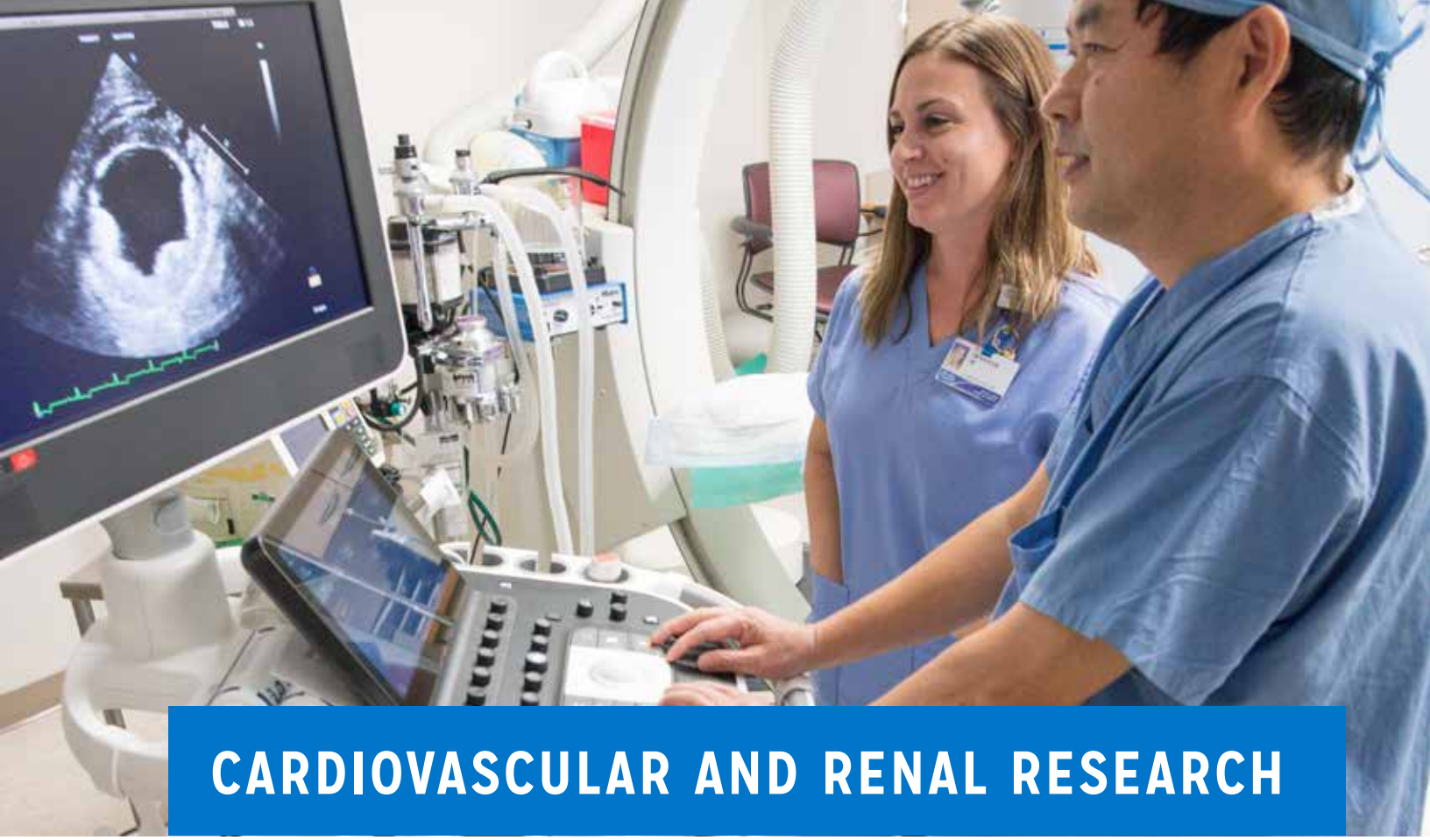

CARDIOVASCULAR AND RENAL RESEARCH

Jiang Xu, Cardiovascular Research, is using echocardiography to study the effects of drugs and devices for the treatment of heart failure.

Cardiovascular Research Lab (Cardiology/Department of Internal Medicine)

The Cardiovascular Research Laboratories of the Division of Cardiology and the Henry Ford Heart and Vascular Institute (HVI) conducts research into the causes and treatments of heart failure. This disease has reached epidemic proportions, affecting more than 6 million patients in the United States and more than 25 million patients worldwide. The general theme is translational research, that is, basic research with a potential for use in humans. This group is also concerned with understanding the basic mechanisms leading to progression of heart failure and ventricular remodeling, including the assessment of novel drugs and devices that may reverse this deleterious process that, if left unchecked, will culminate in the death of the affected patient.

With regards to better understanding of the pathophysiology of heart failure, a major focus of the laboratory during the past few years has been on evaluation of mitochondrial function in heart failure. Mitochondria are components of nearly every cell in the body, including heart and skeletal muscle cells, responsible for the production of energy for the cells to use. Seminal research in these laboratories have shown that mitochondria in heart failure are structurally and functionally abnormal and are unable to generate sufficient energy or ATP to meet the demands of the beating heart. In addition to understanding the role of abnormal mitochondria in driving the heart failure syndrome, the laboratories are also engaged in the development and testing of novel drugs that can improve the function of mitochondria and, in doing so, improve overall heart function. New drugs under investigation include elamipretide, a mitochondria targeting peptide and noladenoson, a partial adenosine A1-recptor agonist. Both drugs are currently being evaluated in clinical trials in patients with heart failure.

Research has also targeted acute decompensated heart failure, a condition resulting from acute worsening of the chronic heart failure state and one which requires urgent hospitalization. Current investigations are focused on understanding the mechanisms involved in cardiac decompensation and on therapies that can improve symptoms and survival. Several novel drugs are being tested for this condition, including compounds that promote vasodilation

along with improvement in contractile dysfunction and compounds. Some of these compounds including some known as nitroxyl donors are currently being evaluated in clinical trials in patients with heart failure.

Beyond molecular biology and traditional biochemistry, the Cardiovascular Research Laboratories are also focused on developing and testing novel devices for treating heart failure. These include percutaneous devices that electrically stimulate nerve endings in the upper thoracic aorta to improve function of the failing heart. The laboratories are also investigating devices that improve the function in heart failure through electrical stimulation of the carotid baroreflex, technology known as Baroreflex Activation Therapy (BAT). Other devices being considered for testing include percutaneously delivered miniature blood pumps that are deployed in the aorta and designed to reduce the workload on the failing heart. In doing so, these devices are expected, over time, to improve the overall ability of the failing heart to pump blood commensurate with the needs of other essential body organs. Lastly, the division is using materials made of seaweed called alginates, deemed by the US Food and Drug Administration as devices, that when injected directly into the heart muscle, help support the failing muscle by preventing progressive enlargement of the heart and reducing wall stress, which, in turn, reduces energy expenditure.

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Cardiology/Internal Medicine

The Preventive Cardiology Unit conducts research across a wide range of exercise testing and exercise training-related topics that address the primary and secondary prevention of disease.

Using large hospital-wide (Henry Ford FIT and FIT-CPX Studies) and other national databases, current research includes further describing the association between reported physical activity, measured metabolic equivalents of tasks (METs), or cardiorespiratory fitness (peak oxygen uptake) and clinical outcomes (incidence of disease, survival). The Preventive Cardiology Unit also engages in investigator initiated, externally funded research that evaluates the effects of exercise training in a broad spectrum of patients with known disease. These trials include cancer survivors (e.g. breast, prostate, lymphoma and colon) at various stages of treatment, patients having undergone left ventricular assist device implant (we conducted the first randomized exercise training trial in the United States), cardiac transplant, and patients with other cardiovascular diseases (e.g. peripheral arterial disease, heart failure, myocardial infarction). This work focuses on the effects of regular exercise training on physiologic adaptations, the development of unique exercise training methods to improve cardiorespiratory function and fitness, and the relationship between regular exercise and clinical outcomes. Our research has also included industry-sponsored trials evaluating the effectiveness of biologics and devices.

In addition to the above, we actively focus on the secondary prevention of cardiovascular disease through the evaluation of novel methodologies to deliver cardiac rehabilitation and exercise training in a manner that targets improved operational efficiencies and patient compliance. Past and current NIH-funded clinical trials in our unit asses the effect of chelation therapy on the risk of morbidity and mortality in patients having survived a myocardial infarction.

Finally, the Preventive Cardiology Unit operates a Clinical Exercise Physiology Core Laboratory Service that supports national and international drug and device trials that include, as one of their main endpoints, an assessment of physical function or fitness (e.g., peak oxygen uptake via cardiopulmonary exercise testing). Since 2002, the Henry Ford Clinical Exercise Physiology Core Laboratory has supported more than 25 national/international level clinical trials.

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Structural Heart Disease (SHD) is a unique, intensive, multi-disciplinary collaboration between cardiac surgery, interventional cardiology, and advanced imaging. The section's research focuses on treating valvular heart disease, cardiac imaging, heart failure, shock, and thrombo-prophylaxis through new technology, devices and pharmacology. SHD has a strong interest in innovation and has been a leader in translational research in collaboration with National Institutes of Health (NIH), responsible for the clinical development of cutting edge technologies and techniques for advancing minimally invasive procedures (e.g. transcaval access, intentional right atrial exit, LAMPOON). Our advanced cardiac imaging investigators in partnership with the Henry Ford Innovations Institute has

yielded seminal research in planning minimally invasive procedures and use of 3D printing to advance medicine. The SHD imaging center functions as a core lab facility for investigational studies, serving as a leader in the imaging field. Furthermore, we are a high volume center and actively recruit for sponsor initiated studies for multiple studies in valvular heart disease, heart failure and left atrial appendage occlusion (PARTNER III, COAPT, AMULET).

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Hypertension and Vascular Research Division/Department of Internal Medicine

High blood pressure (hypertension) is the most common form of cardiovascular disease. Hypertension afflicts more than one in four adults in this country. African Americans and the elderly have significantly greater rates of hypertension than the at-large population. By the age of 60 nearly 65 percent of all Americans will have hypertension. However the causes of hypertension remain poorly understood.

Hypertension is the top leading factor for loss of health worldwide. This is due to the fact that hypertension causes heart disease, which is the major cause of death in the United States, surpassing all forms of cancer combined. Hypertension is a major risk factor for stroke, heart attack, congestive heart failure, kidney failure, and vascular disease. Hypertension directly damages the heart, blood vessels and kidneys. In the heart, it causes enlargement (hypertrophy) and fibrosis (increased connective tissue) of the left ventricle and atrium leading to impaired function of the heart and irregular heartbeats (arrhythmias). Hypertension damages the kidney and when combined with diabetes causes very rapid progression to kidney failure, something that has reach epidemic proportion in the US. In the kidney, hypertension damages the units responsible for filtering the blood and the cells that regulate salt and water excretion. This results in loss of the ability of the kidney to excrete waste products and elevated loss of proteins that normally are found in the blood.

Research in the division focuses on understanding the genetic, molecular and physiological mechanisms that cause hypertension. We study how renal abnormalities increase the prevalence and probability of developing hypertension and also the consequences of elevated blood pressure in the heart, vessels and kidneys. Because hypertension is often associated to diabetes and obesity, we also study the mechanisms by which these diseases interact to damage the kidney and the heart. These topics are addressed by studying how 1) the genes and proteins responsible for the movement of salt and water into and out of the kidney work; 2) these genes and proteins are altered in models of hypertension, by a high salt diet or by a high sugar diet ; 3) inflammation contributes to hypertension-related damage of the heart, vessels and kidney; 4) oxidants and reactive oxygen species are generated in kidney cells, the heart or blood vessels and their role in causing hypertension and organ damage; and 5) diabetes and obesity enhance high blood pressure, damage the heart, and change renal function, leading to cardiovascular and renal disease. Such studies require use of innovative state-of-the-art methodologies, many of which were developed within the division. These include non-invasive echocardiography to measure heart function, real-time telemetric measurement of blood pressure in animals, imaging of cell function in working kidneys by multi-photon microscopy, multi-modality microscopy imaging of renal tubules and renal blood vessels that are 10 times smaller than a human hair, genomic and transcriptomic analysis of isolated cells form the heart and kidney, bioinformatics, in vivo gene transfer, molecular biology, and fluorescence microscopy to study the movement of single proteins in individual cells. Additionally, whole animal physiological and histological studies are performed. These techniques are used in models of human pathology (high blood pressure, obesity, diabetes, metabolic syndrome) that are created by genetically modifying animals or treating them with diets similar to those consumed by the population in the US (high salt, high fructose, high sugar, high fat).

The research in this division is supported by multiple grants from the National Institutes of Health, including one Program Project Grant. These grants are multi-investigator efforts that provide more than $2.5 million in support each year. Other funding sources include the American Heart Association, the Michigan Kidney Foundation and the pharmaceutical industry. In 2016, more than $4 million in total costs was awarded to the division (7 senior scientists and their support staff) to pursue their studies of the causes and consequences of high blood pressure.

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CANCER RESEARCH

Kevin Nelson works with the glioma tissue bank in Neurosurgery.

Henry Ford Cancer Institute Clinical Trials Office

The Henry Ford Cancer Institute Clinical Trials Office consists of 45 physician investigators and 32 research nurses, research assistants and study coordinators who provide a multi-disciplinary approach to cancer care across all the specialty services throughout the System. This is accomplished by providing a centralized clinical research support system through the Clinical Trials Office to all primary departments through which cancer patients are evaluated and treated for their malignancies. These include the Division of Hematology/Oncology and the Departments of Radiation Oncology, General Surgery, Neuro-Oncology, Urology, Gynecologic Oncology and Otolaryngology.

Because of this coordinated effort, the Henry Ford Cancer Institute Oncology program has established both an institutional and national reputation for providing exceptional patient care and quality assurance in conducting cancer clinical trials. Through the mechanisms of the National Cancer Institute-supported cooperative group program and industry-sponsored, consortium and Henry Ford investigator-initiated clinical trials, eligible Henry Ford patients are offered state-of-the-art clinical trials as additional treatment options with various new anti-cancer agents or therapies that are not available under the traditional standard of care. These clinical research-related therapies usually result from cutting-edge scientific advances, often from investigations of novel anti-cancer mechanisms or from studies of cancer cell-specific targets. These newer anti-cancer therapies also provide patients with personalized therapeutic options.

Up to 100 Phase I-IV trials, as well as therapeutic intervention, prevention, observational and compassionate-use oncology clinical trials, are available to Henry Ford Health System cancer patients at any given time. As an active member of an established network of cancer research, the System is privileged to offer patients new anti-cancer drugs and therapies that are available at a very small number of sites nationwide or worldwide.

Cancer Epidemiology, Prevention and Control Program

Investigators and physician scientist collaborators study the causes and risk factors related to cancer with the goal of developing interventions to prevent or delay the onset of new, recurrent and fatal cancers. Studies include the determination of genetic, environmental and lifestyle characteristics that increase the risk for new cancers or worsen prognosis of diagnosed cancers. Experts also study the effectiveness of clinical and behavioral interventions to reduce cancer risk, such as screening tests, nutrition education and smoking cessation education programs. These studies are particularly well suited to the large and diverse population served by Henry Ford Health System. Current highlights include NCI-funded studies of:

- Risk factors for lung cancer among smokers.
- Genetic factors leading to a poor prostate cancer prognosis.
- Statin use as a preventive factor for lymphomas.
- An intervention program to increase fruit and vegetable intake (a known preventive factor for many cancers) in young adults.

(See Public Health Sciences Dept. section for a more complete description.)

Neuro-Oncology Program

The goal of the Neuro-Oncology Research Program in the Hermelin Brain Tumor Center (HBTC) is to improve patient outcomes through excellence in clinical management, enrollment in clinical trials, and a strong translational research program, supported by the second largest brain tumor tissue bank in the US. A current focus of the Neuro-Oncology Program is to work towards ample availability of early and late phase clinical trials to eligible brain tumor patients. In parallel the HBTC participates in multi-institutional collaborations for comprehensive molecular profiling of high and low grade gliomas. In the short term, molecular profiling data provides information on actionable mutations guiding treatment decisions and enrolment in clinical trials. In the long range, the accumulated data will allow the identification of bona fide predictive markers of response for better match of therapies to individual patients.

A major initiative has been on symptom research during the end of life phase of patients with high grade glioma. A first ever prospective study exploring patient symptoms and caregiver bereavement is conducted by Dr. Tobias Walbert. In addition, a first ever randomized trial to assess a facilitator directed early Advanced Care Planning intervention to optimize end-of-life (EoL) decision making

and quality of life of brain tumor patients and their caregivers is under way. Both of these studies are part of the Balakrishna Neuro-Palliative Care Program. This unique program is a collaboration between the Drs. Daniel Newman and Tobias Walbert at the departments of neurology and neurosurgery.

Expansion of the high grade glioma live biobank, established in 2008 through culturing of cancer stem cells, continues. This resource meets high demand for clinically relevant research models, supporting a number of pre-clinical studies in drug sensitivity, mechanism of resistance, predictive biomarkers, and personalized medicine. Basic research coverers several aspects of brain tumor biology, such as the study of cell signaling and developmental pathways, mechanisms of cell invasion, miRNAs, development of cell and nanoparticle based delivery of therapeutics to brain tumors. Bioinformatics analysis of genomic and epigenomics datasets now plays a central role in many brain tumor research projects and clinical initiatives.

Gynecological Oncology

The Gynecological Oncology research program is a multidisciplinary group dedicated to optimize cancer care and improving outcomes of women with gynecologic cancer by collaborating with experts in clinical care as well as experts in translational research to learn more about factors that impact cancer cure. At the clinical level, optimization of cancer care to women with different gynecological cancers is achieved by studying different variables that would impact survival endpoints. We are focusing on two major areas; uterine and ovarian cancer. Current studies are supported by a nationally recognized database for women with endometrial cancer as well as another database for women with ovarian cancer.

At the basic science and translational research levels, we are trying to understand the mechanisms underlying the interactions between commonly used medications e.g. metformin and its impact on the survival of ovarian cancer cell lines. Our second focus is to understand the metabolic alterations unique to ovarian cancer cells that confer chemoresistance and an immunosuppressive environment for the tumor to progress.

Developmental Therapeutics Program

1.Drug Discovery and Development

Research in the Hematology/Oncology Division of the Department of Internal Medicine focuses on the discovery and development of new anti-cancer agents. This is a long, costly, high-risk process. It involves the orchestration of many disciplines, including biologists, biochemists, chemists, pharmacologists and clinical scientists to first define a "hit" and then develop the discovery by laboratory testing, study the drugs pharmacology, toxicity and efficacy, and finally perform clinical trials. Researchers have been testing synthetic and naturally occurring compounds derived from plants, sponges, microorganisms and cyanophytes. They are developing a unique and novel cellular assay that discovers compounds which preferentially target solid tumor cells more effectively than normal cells, then determining the concentration required to kill tumor cells both in culture and in animal models.

Because the National Cancer Institute requires establishing a certain degree of anti-tumor activity in animal studies before further research and eventual clinical trials can be supported, the drug is formulated for injection into animals and tested to determine whether drug levels in the tumor are high enough to achieve a therapeutic response. Some of the compounds developed in the discovery program will ultimately be tested in clinical trials at Henry Ford Health System.

2. Using Viruses to Fight Cancer

Researchers in the Department of Radiation Oncology have developed a novel gene therapy-based approach to treat cancer. This approach utilizes an adenovirus (a virus that causes cold symptoms) to selectively and efficiently deliver therapeutic genes to tumors. Preclinical studies have demonstrated that the virus itself causes cell lysis and has potent anti-tumor activity. The efficacy of viral therapy can be enhanced significantly by including two additional "suicide" genes that render malignant cells sensitive to specific pharmacologic agents and sensitize them to radiation therapy.

This preclinical work has led to four Investigational New Drug (IND) applications and nine FDA-approved, investigator-initiated clinical trials targeting prostate, pancreatic, and lung cancer. Henry Ford's initial trial was the first FDA-approved gene therapy trial involving use of a replication competent, oncolytic adenovirus to deliver a therapeutic gene in humans. Patient enrollment criteria required evidence of locally recurrent prostate cancer after radiation failure. Five-year follow-up

showed a significant slowing of disease progression in patients that received the gene therapy. Ten-year follow-up showed an improvement in disease-specific survival relative to well-matched historical controls.

A second trial was the first to combine oncolytic viral therapy with radiation therapy. This study enrolled patients with newly diagnosed prostate cancer. Post-treatment prostate biopsies showed a significant increase in cancer-free patients at two years. Based on these encouraging results, an improved second-generation adenovirus was developed and used in a randomized, controlled phase 2 trial of prostate cancer and phase 1 trial of pancreatic cancer. In the phase 2 trial of prostate cancer, the gene therapy reduced by 42% the percentage of men who had cancer in their prostate 2 years after treatment. A new lung cancer trial using this same agent will be initiated in 2017. In October 2010, Henry Ford investigators were awarded a US patent on this virus and it has been licensed to a pharmaceutical company for further development.

Several third-generation adenoviruses have been developed that stimulate the anti-tumor immune response and can impact both local and metastatic disease. These new agents have demonstrated promising anti-tumor activity in preclinical models of prostate and pancreatic cancer. One virus is now being evaluated in a phase 1 trial of prostate cancer. Additional trials in pancreatic and lung cancer and being planned.

3. Novel radiation therapies

Henry Ford's Radiation Physics Division (Department of Radiation Oncology) carries out investigator-initiated and collaborative research with the primary objectives of investigating novel radiation therapy applications and translating them into clinical practice. The goals are to improve tumor targeting accuracy, reduce collateral radiation damage to healthy tissues and ultimately improve outcomes of cancer patients receiving radiation therapy. Areas of focus include image-guided radiotherapy and image-guided adaptive radiotherapy strategies, MRI for simulation and treatment, Monte Carlo IMRT optimization, novel means of biological modeling and deformable image registration approaches. The HFHS Radiation Oncology department is at the forefront of the use of cutting edge technologies toward fighting cancer. They were the first in North America to implement a new treatment machine dedicated toward treating tumors with stereotactic radiation.

Research is conducted on 4D-treatment planning in terms of motion management, dose accumulation, dose optimization and adaptive re-planning strategies. Faculty also actively engage in clinically-oriented research, such as exploring the utility of magnetic resonance imaging for treatment simulation, , advanced treatment planning techniques including arc therapy and stereotactic body radiotherapy, supporting databases for multiple treatment sites that assist in outcomes-related research. The division's research efforts are supported by a variety of funding sources, including the National Institutes of Health and industry sponsors.

4. Protecting healthy tissue

Investigators in the Henry Ford's Radiation Biology Division (Department of Radiation Oncology) focus on two major research areas: 1) Developing effective pharmacological strategies to reduce early and late normal tissue injury following tissue, organ and total body radiation exposure and 2) Enhancing the radiation therapeutic ratio by inhibiting pro-inflammatory cytokines.

Efforts span preclinical studies through clinical trials. Investigators at Henry Ford Hospital were the first to demonstrate that angiotensin converting enzymes (ACE) inhibitors mitigate brain radiation injury and do not protect tumor from radiation damage. Other agents that have showed promise include statins, HDAC inhibitors and anti-oxidants. Henry Ford investigators were also the first to demonstrate that stem cell mobilizers reduce radiation injury including soft tissue damage and radiation lethality. Inflammation is one of the hallmarks of both solid cancer growth and normal tissue complications after radiation exposure. Reducing inflammation after radiation therapy has the potential to improve tumor response to radiation and normal tissue radiation injury. Pro-inflammatory cytokines are associated with inflammation and are used as a biomarker of both tumor and normal tissue inflammation. Investigators at Henry Ford have partnered with drug development experts at Northwestern University (Chicago, IL) and medical countermeasure experts at Humanetics Corporation, Inc. (Edina, MN) to improve the therapeutic ratio of radiation therapy through anti-inflammatory strategies. Research efforts address the need to reduce late normal tissue complications

in cancer patients receiving radiation therapy as treatments become more effective and patients are living longer. Research also fulfills the US government initiative to have available radiation injury countermeasures in case of radiological attack or nuclear disaster. Research efforts are funded by the NIH and industry sponsors.

Otolaryngology-Head and Neck Research

Despite considerable efforts, the 5-year survival rate for head and neck squamous cell carcinoma (HNSCC) has not changed significantly. Patients with advanced HNSCC are limited to a complete response of 50% and often require long-term rehabilitation. However, early detection increases survival to 80%. To facilitate timely diagnosis and improve treatment and prognosis, elucidation of early detection markers is crucial. Our current focus is on genetic, epigenetic, transcriptomic, and infection makers for early detection, diagnosis, and prognosis of HNSCC. There is also interest in why there is a high mortality rate and disparate unfavorable diagnosis and prognosis outcomes for African Americans (AA).

Oncogenic human papilloma virus (HPV), particularly HPV-16, is a causative agent for some HNSCC and an independent risk factor for oropharyngeal HNSCC. HPV positive patients with HNSCC, particularly oropharyngeal cancer, have improved prognosis. We have created HPV-positive and HPV-negative cell lines to further characterize the pathogenesis of these tumors. To search for new drugs targeted specifically for HPV-positive and HPV-negative tumors, these cell lines are also being examined for drug response differences.

Recent clinical advances with drugs that block immune checkpoints, such as Nivolumab, have brought immunotherapy out of the realm of highly specialized therapy and into the main×stream of oncology. The challenge has been to find out why some patients respond whereas others do not. Thus, there is intense interest in identifying biomarkers to guide patient selection based on predicted efficacy and/or toxicity. Our goal is to establish genetic markers as 1) novel immune biomarkers informative for the presence of an inhibitory milieu of tumor immune infiltrating cells (TILs) and relatedly useful in predicting prognosis in HNSCC and 2) a predictor of high mutational load (using next generation sequencing) and therefore as having likely utility as a biomarker of response to immune checkpoint therapy in HNSCC.

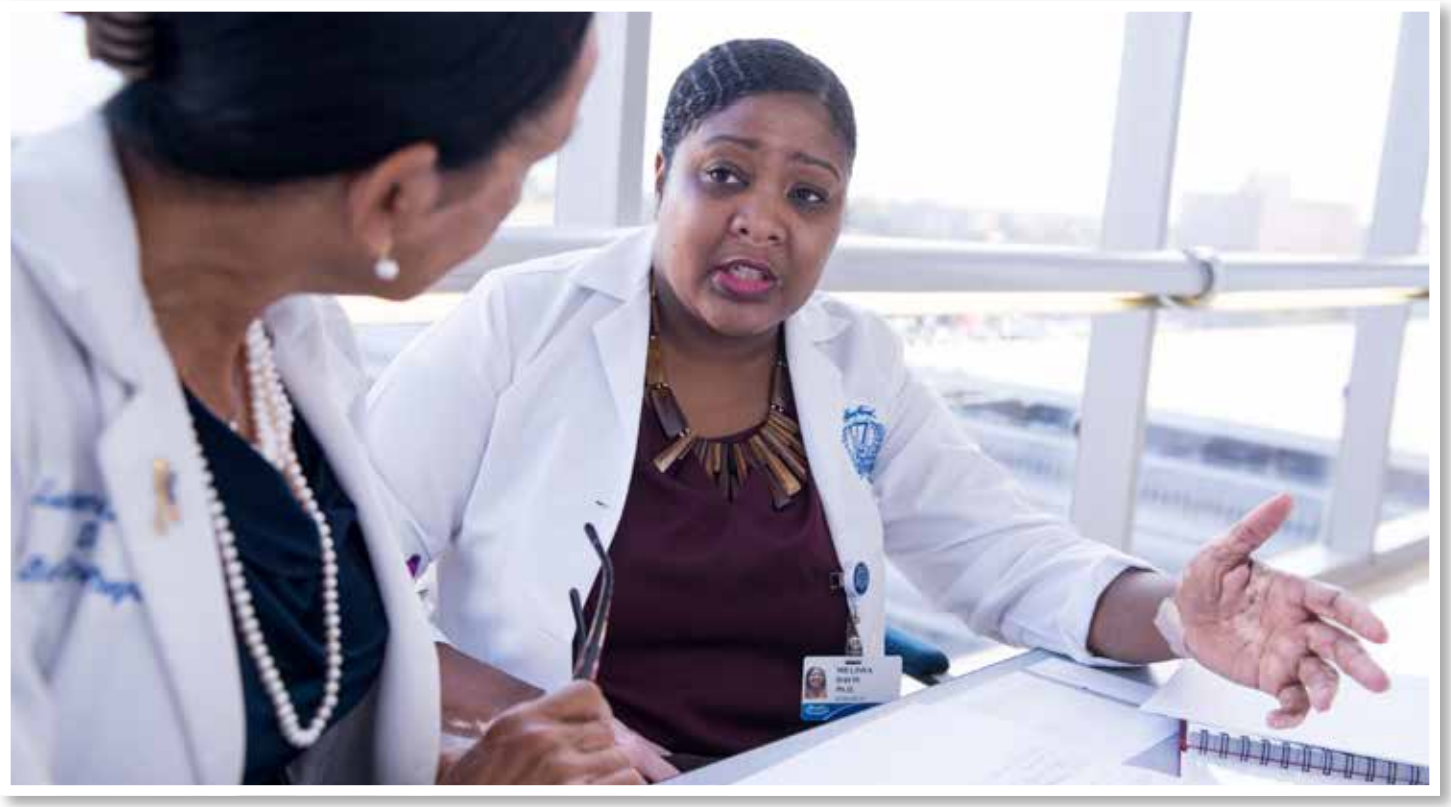
Another program research focus is developing and confirming thyroid-specific DNA methylation markers with predictive and prognostic value for thyroid cancer and follicular adenomas as well as offering insights in to the molecular delineation of thyroid cancer subtypes. The goal is to identify predictors of outcome (benign versus cancer) as well as differentiate follicular thyroid carcinoma from a benign follicular adenoma. The latter is of high clinical significance because morphologic overlap with benign thyroid nodules makes it virtually impossible to definitively differentiate follicular thyroid carcinoma from benign follicular adenoma.

Keloid molecular studies have focused primarily on genetic mechanisms. These approaches have yielded some tangible results, albeit with large gaps in our understanding of keloid pathogenesis. As an alternative mechanism for regulating genes, epigenetics may explain why gene mutations alone do not provide definitive mechanisms for keloid formation. Because clinical options for the treatment of keloids has been disappointing, methylated genes involved in keloid pathogenesis would serve as potential treatment targets. The potential reversibility of DNA methylation patterns would suggest these as viable molecules for novel targeted treatment strategies to block the growth and development of keloids and improve clinical outcomes.

Breast Cancer Research

1.African Ancestry and Triple Negative Breast Cancer (TNBC)

Over the past several decades considerable advances in reducing the burden of breast cancer have been made. Mortality rates have declined as a result of advances in treatment and the wide dissemination of breast cancer screening, and for the first time in decades we have seen incidence rates fall. However, there are certain types of breast cancer that continue to have a poor prognosis and whose rates are not declining, and so advances that improve outcomes for patients with these types of breast cancer are still desperately needed. A widely accepted and well validated approach to categorizing breast cancer is based on its molecular profile. The most common of these molecular subtypes are so-called luminal A tumors, which also have the best prognosis with an approximately 90% 5-year survival rate. In contrast, three other types of breast cancer, basal-like [which have the triple-negative (TN) phenotype], HER2-overexpressing (H2E), and luminal B tumors, have appreciably poorer prognoses with 5-year survival rates ranging from 30-80%. Additionally, while



Melissa Davis PhD (right) discusses her genetic data regarding triple negative breast cancer incidence and health disparities.

basal-like and H2E tumors account for only ~25% of all breast cancer cases, they disproportionately affect young women, African American women, and Hispanic women, and thus are of considerable clinical and public health importance. We are currently focused on identifying and validating DNA methylation profiles with predictive and prognostic value for ER-negative breast cancer and to then translate these findings into potentially clinically useful subtype specific risk prediction models.

Recognition of breast cancer disparities between African-American and White American women has generated exciting research opportunities investigating the biologic and hereditary factors that contribute to the observed outcome differences, leading to international studies of breast cancer in Africa. The study of breast cancer in women with African ancestry has opened the door to unique investigations regarding breast cancer subtypes and the genetics of this disease. In particular, studies are underway to compare gene expression in triple negative breast cancer (TNBC) patient samples to help determine if shared ancestry, population migration and reproductive patterns contribute to the development of specific subtypes of TNBC and better define TNBC subtypes in diverse populations.

2. Benign Breast Disease (BBD):

The majority of studies reporting risks of breast cancer from BBD address predominantly homogenous Caucasian American cohorts, limiting our understanding of how those risk factors affect other ethnic groups. The successful construction of the NIH Detroit BBD cohort with nearly 28% African American women and its successful collection of follow-up information on 95% of the cohort have added to our knowledge of BBD in African American women. Our current focus is to assess whether reduction in risk of breast cancer among those women whose breast tissue has undergone extensive lobular involution is independent of other markers of risk, including BBD lesion composition, multiplicity, and race. In determining whether the protective effect of lobular involution extends to African women with BBD, it should be possible to increase the predictive ability of breast cancer risk models to benefit minority populations as well.

Urologic Oncology Program

The urologic oncology program focus on basic and clinical research on urological cancer particularly kidney cancer, bladder cancer and prostate cancer. Ongoing active collaboration between clinician scientists and basic science researchers is a strong aspect of this program. The major theme of the program is on the discovery and validation of novel cancer biomarkers and development of therapeutic agents in a translational research perspective for early detection, treatment and monitoring disease progression. The overarching goal of this program revolves around approaches on clinical research, drug discovery, genomics, cancer biology and bioinformatics. A team of principal investigators with expertise in diverse areas of cancer research is an asset to this program engaging in various aspects of urological cancer research.

Current research projects are focused on

a) The discovery and validation of biomarkers using next generation sequencing technology and related methods. With the discovery of new molecular markers by us and others in the field, we were able to classify prostate cancer into distinct molecular subtypes and understand their implication in disease progression and outcome.

b) With the identification of new molecular markers, we attempt to understand the prevalence of these markers in a multi focal prostate cancer to understand the role of inter- and intra- tumor heterogeneity and correlate with clinical outcome.

c) Understand the regulation of prostate cancer cell survival by 5-lipoxygenase (5-lox) and targeting 5-lox for prevention and treatment of prostate cancer.

d) Clinical trials for patients with genitourinary cancer supported by pharmaceutical and investigator-initiated trials and cooperative group trials.

e) Advancing translational research in collaboration with clinician scientists in the areas of studying biomarkers and circulating tumor cells and evaluating apoptosis biomarkers as an early predictive marker of therapeutic benefit in patients with metastatic prostate cancer.

f) Identifying factors that influence treatment resistance in advanced prostate cancer.

g) To understand the treatment resistance mechanism, projects are being undertaken to understand the role of androgen receptor in telomere stability and identify factors responsible for expression of androgen receptor splice variants.

h) To develop effective treatment options for prostate and bladder cancer, approaches targeting the intracellular redox systems are being worked out.

i) The identification of new molecular subtypes of clear cell renal cell carcinoma.

Nalla Palanisamy PhD examines new molecular markers identified in prostate cancer tumors.

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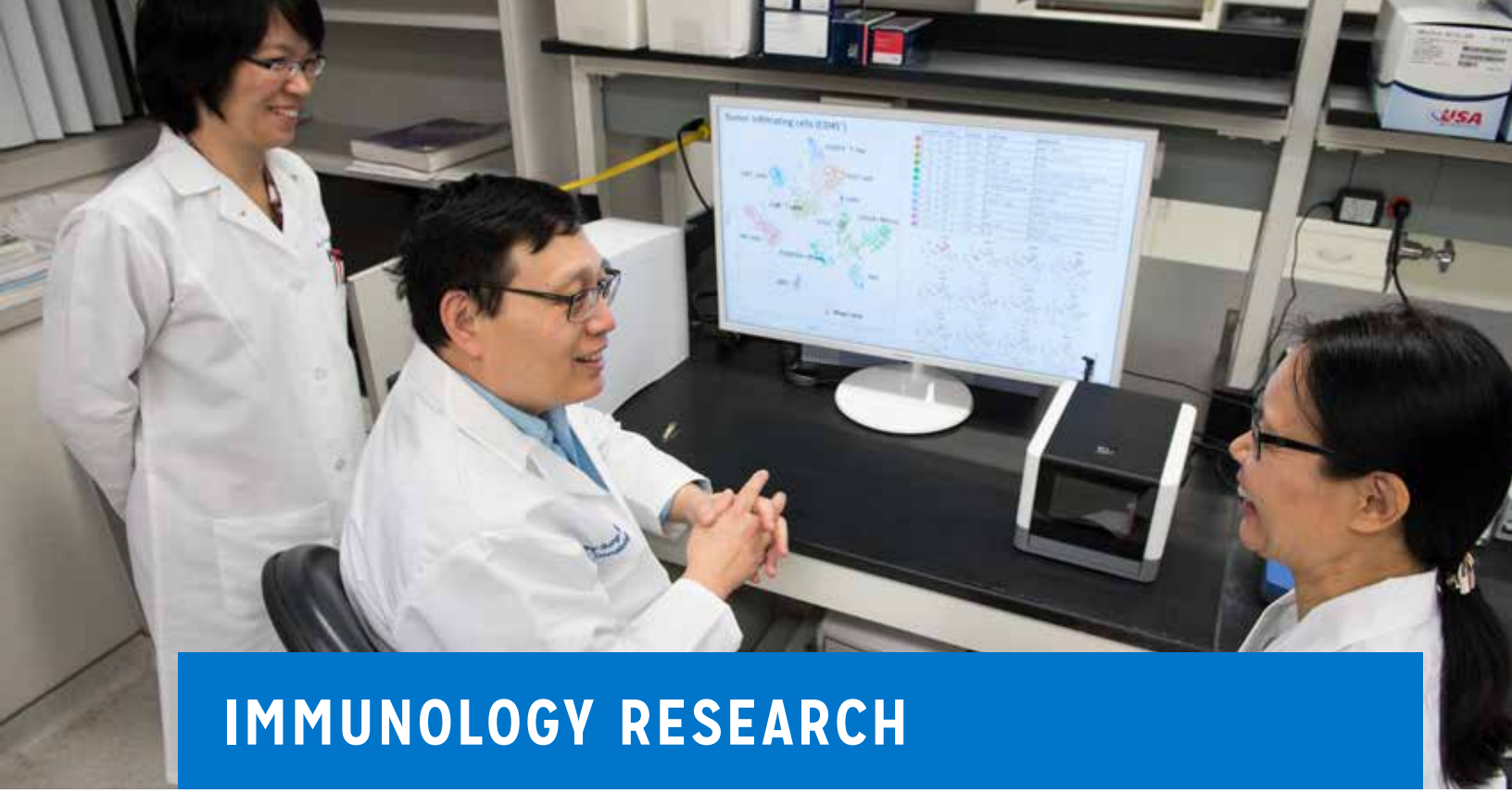

IMMUNOLOGY RESEARCH

Drs. Yi Yao, Qing-sheng Mi and Li Zhou discuss gene expression profiles of serum biomarkers for disease prediction, diagnosis and therapy response in skin diseases.

The Immunology Research Program (IRP), established in 2008, is part of the Henry Ford Cancer Institute & the Center for Cutaneous Biology and Immunology Research, Department of Dermatology. The IRP focuses on both basic and clinical immunology, related to cancer, autoimmune and inflammatory diseases. The IRP enables basic and clinical investigators to work together to advance the battle against diseases through translational research, ultimately resulting in improved clinical care. Currently, the IRP has two Investigators with NIH and foundation grants and expects to have 4-5 new Investigators by 2022.

Dysregulated immune development and functions are the major causes for cancer, autoimmune and inflammatory diseases. Epigenetic regulation, including histone modification and noncoding RNAs, plays key roles in immune cell development and function. Using a variety of genetically modified mice as disease models and state-of-the-art technologies, the IRP researchers have identified multiple epigenetic factors, including noncoding RNAs and histone modification enzymes, in the development and function of Immune cells including natural killer T cells (NKT), γδT cells, tissue resident macrophages and dendritic cells, which are related to cancer and autoimmune/inflammatory disease development. These findings will shed new light on the pathogenesis of immune-related diseases and eventually lead to novel immunotherapy strategies for the treatment. In addition, the IRP researchers also focus on the precision medicine. Using high throughput gene expression profiles, the IRP researchers identified small non-coding RNAs, called miRNAs as potential serum biomarkers for disease prediction, early diagnosis and immunotherapy response, including type 1 diabetes, vitiligo, gout, arthritis, and melanoma. These studies will contribute to future disease management and treatment selection.

The Dermatology Clinical Research Unit conducts state-of-the-art, high-impact clinical trials involving all aspects of general dermatology. We have over 20 years of experience conducting phase 2, 3 and 4 trials. Our mission is to participate in the development of novel treatments that will enhance the lives of our dermatology patients.

The Immunology Research Program is led by Qing-sheng Mi, MD, PhD, qmi1@hfhs.org, 313-876-1017. Contact information for the Dermatology clinical research program is Linda Stein Gold, MD, lstein1@hfhs.org, 313-916-1984.

BONE AND JOINT DISEASE RESEARCH

Jaime Fitzgerald PhD and Anais Fradet PhD examine connective tissue cells growing in culture.

The mission of the Bone and Joint Center of the Department of Orthopaedic Surgery is to perform integrated, state-of-the-art research into the musculoskeletal system with the goal of understanding disease processes and developing new treatments. Five bioscientific investigators pursue research programs in the structure, function, and pathology of musculoskeletal tissues, and interact with clinicians who also conduct research. Osteoarthritis, osteoporosis and other bone and joint disease processes are studied in the laboratories, which are equipped to accommodate a full spectrum of research projects, from bioengineering to cell biology. Studies are funded by the NIH, Department of Defense and the pharmaceutical industry.

The Cell Biology section focuses on changes in chondrocyte behavior associated with cartilage degeneration in osteoarthritis. Our current focus aims at understanding the regulation of chondrocyte differentiation and the maintenance of the chondrocyte phenotype. Studies are also underway to identify genes that are essential for the survival of chondrocytes in chondrosarcomas, the second most common primary bone tumor. We have also investigated the role of microRNAs in maintaining cartilage integrity and the capacity of levels of non-coding RNAs (including microRNAs) in serum to predict cartilage pathology in early post-traumatic osteoarthritis.

The Musculoskeletal Genetics laboratory is focused on understanding the role extracellular matrix proteins play in connective tissue pathologies of cartilage, bone and muscle. The laboratory uses high throughput sequencing and functional genomics to define the genetic basis of Mendelian disorders in these tissues. Current projects investigate the genetic basis of chondrodysplasia, congenital muscular dystrophies and clubfoot.

Yener Yeni PhD and Dan Oravec prepare a bone sample for biomechanical testing.

The Mechanobiology section focuses on: 1) cell-signaling mechanisms that govern the mechanical behavior of bone and its adaptation to mechanical loading, 2) cell-signaling mechanisms that enhance tissue growth and invasion of engineered scaffolds, and 3) developing treatment and prevention strategies of musculoskeletal diseases such as osteoporosis and arthritis. Ongoing research is also investigating the use of exercise as a form of mechanical loading to increase bone formation and overall strength.

The Biomechanics laboratory is focused on improving the diagnosis of bone fracture risk associated with osteoporosis and improving techniques for preventing and treating fractures. High-resolution imaging, computer simulation, mechanical testing and microscopy techniques are used to estimate how mechanical stress is distributed in bone, quantify the chemical and structural makeup of tissue, and estimate bone strength and fracture risk. New techniques are developed using imaging modalities such as tomosynthesis to quantify bone properties that predict fracture risk.

The Herrick-Davis Motion Analysis Laboratory studies the dynamic function of human joints and mechanical factors associated with degenerative joint and soft-tissue diseases. Ongoing studies are aimed at understanding how the treatment of rotator cuff tears affects long-term shoulder function, the impact of fusion and artificial disc replacement on spine motion, and the effects of surgical reconstruction techniques on knee and elbow function.

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CLINICAL RESEARCH HIGHLIGHTS

Dr. Joseph Miller, Emergency Medicine, examines a patient in one of this clinical trials.

Emergency Medicine

Emergency care research covers a wide breadth of investigative areas and funding sources. First, Henry Ford Health System serves as a hub for the Neurological Emergency Treatment Trials (NETT) Network that is transitioning into the NINDS- and NHLBI-funded SIREN Network. Henry Ford is a regional coordinating center for conducting phase 3 clinical trials of treatments for stroke, traumatic brain injury, seizure, cardiac arrest and other neurological or cardiopulmonary emergencies. This network is currently conducting studies on tight glycemic control for acute stroke, clopidogrel for transient ischemic attack, and second line treatment for status epilepticus. Henry Ford Health System is also a member of the NHLBI-funded PETAL Network, a collaboration of centers investigating early strategies to reduce acute lung injury. Current studies include a randomized trial of vitamin D for prevention of acute lung injury in high risk patients. Both the PETAL and NETT/SIREN networks include close collaboration with Neurology, Medical Critical Care, Surgical Critical Care, and Neurocritical Care. Emergency care research within the HFHS has an additional emphasis on the development of cardiac biomarkers. Current studies include biomarker development with companies such as Roche, Abbot, Siemens and others. The department has established a biobank, which is being developed in partnership with industry investment. Another research focus is in the area of general critical care and hemodynamic monitoring. Through extramural federal funding and industry partnerships, critical care research includes studies on hypertensive emergencies, cardiac emergencies, septic shock and non-invasive hemodynamic monitoring. Lastly, the department has strong involvement in NIH funded basic science work, particularly in the area of pre-clinical stroke models. Work on the neuroprotective effects of thymosin-**β** is ongoing.

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Infectious Diseases (Internal Medicine)

The division's research interests focus on infectious disease diagnostics, transplant infectious diseases, infections in immune compromised patients, prevention of hospital-associated infections, fungal infections, infection due to antibiotic-resistant bacteria, and HIV/AIDS. The division has a strong interest in Public Health, Global Health, and underserved populations. Using the strength of its clinical volume and diverse spectrum of infectious diseases, the division is partnering with colleagues both inside and outside the institution to develop and test new assays for infectious diseases and to participate in clinical trials for new anti-infective treatment. Research in the division is funded by the CDC, NIH and pharmaceutical company partners.

The research interests of the division include a combination of translational basic science, laboratory, outcomes and clinical studies. Staff work to bridge the application of bench research to the patient bedside. Specific investigations include the study of the epidemiology and treatment of various antibiotic-resistant bacteria, outcomes and new therapies for HIV/AIDS, and epidemiology and development of rapid and specific testing and new treatments for fungal infections in immune-compromised patients. The laboratory serves as a repository for thousands of microorganisms, and the clinical trials unit a coordinating center for various multinational studies.

Contact information: Marcus Zervos, M.D., Division Head, mzervos1@hfhs.org, 313-916-2573; Eric Scher, M.D., Department Chair, escher1@hfhs.org, 313-916-1828.

Sleep Research (Pulmonary Division/ Internal Medicine)

Researchers at the Sleep Research Laboratory pursue insomnia, psychopharmacology, shift work disorder and sleep-related respiratory and movement disorder research. As a disorder of arousal, insomnia research investigations include the pathophysiology and morbidity of insomnia as well as behavioral and pharmacological treatments. Research is also focused on insomnia and the HPA axis as well as the identification of gene candidates for insomnia predisposition. Psychopharmacology research explores the relation of sleep, sleep disorders and variations in sleep as they relate to the use of a variety of drugs. Research ranges from identifying and evaluating safety and efficacy to understanding sleep mechanism-mediating substance abuse.

Investigators are conducting research aiming to elucidate the pathophysiology of shift work disorder as a distinct clinical entity seen in shift workers. Research focuses on identifying the morbidity associated with shift work disorder, specifically the neural substrates of this morbidity. Behavioral and pharmacological

treatments for shift work disorder are being developed and evaluated. Clinical research on a variety of sleep-related respiratory and movement disorders is also ongoing.

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Psychiatry/Behavioral Health Research

A burgeoning area of research at Henry Ford Health System is in the field of psychiatry. The Psychiatry Research program is a joint venture between Behavioral Health Services and the Center for Health Policy & Health Services Research, and involves a staff of scientists and research personnel as well as administrative leaders, clinical providers, and patients. Members of Psychiatry Research have significant involvement in three major consortia, which drive a significant line of research in the areas of epidemiology, health services, prevention, and intervention. These consortia include the NIMH-funded Mental Health Research Network and the Health Systems Node of the NIDA Clinical Trials Network – both networks involve research collaborations across 17 diverse healthcare delivery systems across the nation that are all affiliated with the Health Care Systems Research Network. Several multi-site studies and trials involving Henry Ford are ongoing in numerous areas. In addition, the Psychiatry Research team is integrally involved, along with Public Health Sciences, in leading a healthcare provider organization network within the NIH's All of Us Precision Medicine Initiative Cohort Program.

The Psychiatry Research team has particular expertise in the areas of suicide prevention, opioid use disorders, and mood disorders. Among the many ongoing projects are studies focusing on understanding of clinical risk factors for suicide, examining technology-based interventions for youth with substance use disorders, evaluating the prospective risk of addiction and other outcomes after initiation of opioid therapy, and comparing treatment approaches for mental health conditions within a variety of clinical care settings. The team also partners with leadership in Psychiatry to monitor public health outcomes for patients, determine priorities and conduct needs assessments, as well as provide expertise to fuel quality improvement programs, such as the department's award-winning Perfect Depression Care Zero Suicide Initiative.

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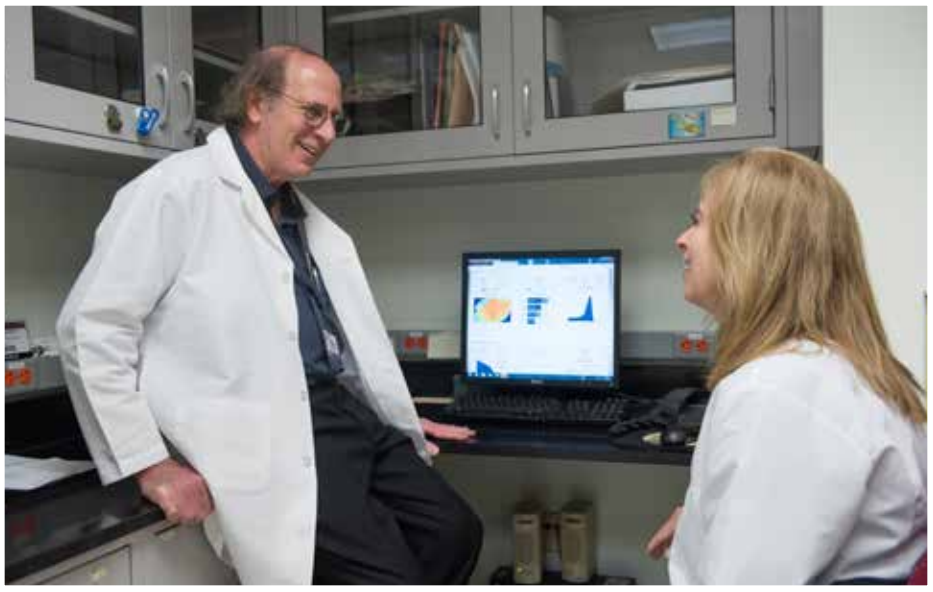
Surgery

The Department of Surgery is involved in several cutting-edge clinical trial research studies to advance the effectiveness of diagnostic, decision-support, surgical and post-surgical tools and devices. We are currently participating in surgical clinical trials in the area of:

- Cancer – pancreatic, esophageal, lung and triple-negative breast cancers;
- Cardiac - Evaluation of several left ventricular assist systems; safety and efficacy of intramyocardial injection of stem cells in LVAD patients;
- Plastics – overlay system to reduce hospital-acquired pressure ulcers in the peri-operative setting; breast reconstruction and body contouring after bariatric surgery.
- Vascular – CREST-2 study designed to find the best way to prevent strokes (i.e., medical management plus either carotid endarectomy or stenting); BEST-CLI Trial funded by NHLBI to evaluate the effectiveness of 2 revascularization protocols in patients with critical limb ischemia;



Dr. Norm Markowitz (left) discusses new therapy approaches for the treatment of HIV/AIDS.

Dr. Stu Gordon (right), Gastroenterology, is involved in many clinical studies of viral liver disease.

- NASA- Fluid shifts study on the International Space Station to evaluate acute and chronic changes in fluid dynamics in long duration astronauts;
- NASA- SPINE study on the International Space Station to evaluate the effects of long duration exposure to microgravity on the spine;
- National Space Biomedical Research Institute (NSBRI)- COMFORT ground-based study to evaluate non-physician astronaut performance of complex medical tasks using just in time training software;

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Gastroenterology and Hepatology (Internal Medicine)

The Hepatology research section consists of six hepatologists, two hepatology physician assistants, and a clinical research team that includes 15 staff members that are registered nurse, clinical research coordinators, clinical research assistants and project coordinators. The major focus of clinical hepatology research involves the treatment of viral hepatitis, non-alcoholic steatohepatitis, and primary biliary cholangitis. Other divisional research protocols involve the management of primary liver cancer, fatty liver disease, hepatic encephalopathy, and hepatorenal syndrome.

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CLINICAL RESEARCH HIGHLIGHTS

SUMMARY OF GRANTS, CONTRACTS AND SUBCONTRACTS AWARDED TO HFHS

Funding Agency	Awarded Jan - Dec 2018
NATIONAL INSTITUTES OF HEALTH	$39,805,401
OTHER FEDERAL AWARDS	$5,583,159
PHARMACEUTICAL / INDUSTRIAL AWARDS	$36,813,175
STATE & LOCAL AGENCY AWARDS	$1,587,312
FOUNDATION & OTHER AWARDS	$2,363,736
TOTAL	**$86,152,783**

2018 Active Grant and Contract Funding from the National Institutes of Health

Project Leader	Project Title	NIH Institute
BRIAN AHMEDANI	TREATMENT UTILIZATION BEFORE SUICIDE (TUBS)	NIMH
BRIAN AHMEDANI	EVALUATING THE IMPACT OF CHANGES IN OPIOID PRESCRIBING ACROSS HEALTH SYSTEMS IMPLEMENTING ZERO SUICIDE	NIMH
BRIAN AHMEDANI	DEVELOPING TOOLS TO EVALUATE THE IMPACT OF SAFETY PLANNING AND LETHAL MEANS ASSESSMENT ON SUICIDE OUTCOMES	NIMH
BRIAN AHMEDANI	AN EVALUATION OF THE NATIONAL ZERO SUICIDE MODEL ACROSS LEARNING HEALTHCARE SYSTEMS	NIMH
MESER MALI	TREATMENT OF GLIOMA WITH NANOCOMBRETASTATIN WITH MRI MONITORING	NCI
MICHAEL J. BEY	SHOULDER FUNCTION AFTER ROTATOR CUFF REPAIR	NIAMS
MICHAEL J. BEY	SHEAR WAVE ELASTOGRAPHY TO PREDICT REPAIR TISSUE HEALING AND SHOULDER FUNCTION AFTER ROTATOR CUFF REPAIR	NIAMS
JORDAN BRACISZEWSKI	PROMOTING SMOKING CESSATION AMONG YOUTH EXITING FOSTER CARE	NCI
OSCAR A. CARRETERO	AUTOCOIDS IN HYPERTENSION: PATHOGENESIS AND END ORGAN DAMAGE	NHLBI
ANDREA E. CASSIDY-BUSHROW	DELIVERY MODE; ENVIRONMENT AND THE GUT MICROBIOME: INFLUENCE ON CHILDHOOD BODY SIZE	NICHD
JIELI CHEN	DIABETIC STROKE CARDIAC DYSFUNCTION; TREATMENT WITH CD133+EXOSOMES	NHLBI
JIELI CHEN	NEURORESTORATIVE THERAPY OF STROKE WITH HUCBC IN TYPE TWO DIABETIC MICE	NINDS
JIELI CHEN	MIR-126/ABCA1 MEDIATES EXOSOME INDUCED NEURORESTORATIVE EFFECTS AFTER STROKE IN T2DM MICE	NINDS
PHILIP CHENG	CLINICAL TRANSLATION OF PHENOTYPES OF SHIFT WORK DISORDER	NHLBI
MICHAEL CHOPP	MIR-17-92 EXOSOME TREATMENT OF STROKE	NINDS
XU CUI	ABCA1 REGULATES WHITE MATTER REMODELING AND OLIGODENDROGENESIS AFTER STROKE	NINDS
MELISSA B. DAVIS	THE DARC SIDE OF BREAST CANCER	NCI
CHRISTOPHER L. DRAKE	SLEEP TO REDUCE INCIDENT DEPRESSION EFFECTIVELY (STRIDE)	NIMH
CHRISTOPHER L. DRAKE	BEHAVIORAL TREATMENT OF MENOPAUSAL INSOMNIA; SLEEP; DEPRESSION; DAYTIME OUTCOMES	NINR
JAMES R. EWING	MRI SIGNATURES OF RESPONSE TO HIGH-DOSE RADIOTHERAPY IN RAT MODELS OF CEREBRAL TUMOR	NCI
JAMIE FITZGERALD	THE ROLE OF SHIP2 IN MINERALIZATION	NIAMS

CARRI GLIDE-HURST	DEVELOPMENT OF ANATOMICAL PATIENT MODELS TO FACILITATE MR-ONLY TREATMENT PLANNING	NCI
STUART GORDON	CHRONIC HEPATITIS COHORT STUDY	NCHHSTP
QUAN JIANG	IMPAIRMENT OF THE GLYMPHATIC SYSTEM IN THE AGED DIABETIC BRAIN	NIA
QUAN JIANG	GLYMPHATIC AND COGNITIVE IMPAIRMENT OF AGING AND DIABETES	NIA
QUAN JIANG	INVESTIGATION OF D-4F EFFECTS OF NEUROVASCULAR REMODELING AFTER DIABETIC STROKE	NINDS
CHRISTINE C. JOHNSON	PETS AND THE INFANT MICROBIOME: EFFECT ON IMMUNE MATURATION & ATOPIC ASTHMA	NIAID
CHRISTINE C. JOHNSON	PERSONALIZING CARE FOR OBESE PATIENTS IN AN URBAN HEALTH SYSTEM	AHRQ
CHRISTINE C. JOHNSON	TRANS-AMERICA CONSORTIUM OF THE HEALTH CARE SYSTEMS RESEARCH NETWORK FOR THE ALL OF US RESEARCH PROGRAM	OD
LAMONT JONES	CHARACTERIZATION OF KELOID SPECIFIC EXOSOMES AND DETERMINATION OF EXOSOMAL CRITICAL SIGNALING PATHWAYS….	NIGMS
STEVEN J. KETEYIAN	THE IMPROVING ATTENDANCE TO CARDIAC REHABILITATION (IATTEND) TRIAL	NHLBI
JAE HO KIM	IMPROVING THE RADIATION THERAPEUTIC RATIO BY INHIBITING PROINFLAMMATORY CYTOKINES	NCI
DAVID E. LANFEAR	PLASMA METABOLOMICS AND MYOCARDIAL ENERGETICS IN HEART FAILURE	NHLBI
XIANSHUANG LIU	TRANSLATIONAL STUDY OF MIR-146A GENE THERAPY FOR DIABETIC PERIPHERAL NEUROPATHY	NIDDK
MARIELA MENDEZ	HYDROGEN PEROXIDE STIMULATES RENIN RELEASE: ROLE IN HYPERTENSION AND DIABETES	NIDDK
QING-SHENG MI	MICRORNAS AND NKT CELL DEVELOPMENT AND FUNCTION	NIAID
QING-SHENG MI	ROLES OF HDAC3 IN EPIDERMAL LANGERHANS CELL ONTOGENY AND FUNCTION	NIAMS
PABLO A. ORTIZ	FRUCTOSE INDUCED SALT-SENSITIVE HYPERTENSION: ROLE OF THICK ASCENDING LIMB TRANSPORT	NIDDK
SURESH PALANIYANDI	4-HYDROXY-2-NONENAL IN MITOCHONDRIAL DNA DAMAGE AND CONTRACTILE DYSFUNCTION IN DIABETIC HEART: A ROLE FOR ALDH2	NHLBI
TENGIS S. PAVLOV	REGULATION OF ENAC IN SALT-SENSITIVE HYPERTENSION VIA INFLAMMATION-INDUCED ROS PRODUCTION	NHLBI
LAILA M. POISSON	MOLECULAR AND CLINICAL EVALUATION OF THE GLIOMA PATIENT EXPERIENCE TO ANTICIPATE MODERN OUTCOMES AND GUIDE PATIENT CARE	NCI
NOUR-EDDINE RHALEB	AC-SDKP IN THE TREATMENT OF CARDIAC DYSFUNCTION IN HYPERTENSION OR ISCHEMIC HEART	NHLBI
TIMOTHY A. ROEHRS	RISKS FOR TRANSITION FROM THERAPEUTIC HYPNOTIC USE TO ABUSE	NIDA
BENJAMIN A. RYBICKI	A NESTED CASE-CONTROL STUDY OF PROSTATE CARCINOGENESIS	NIEHS
JASPREET SINGH	PLASMA BIOMARKERS OF CEREBRAL DISEASE IN X-LINKED ADRENOLEUKODYSTROPHY	NINDS
LEI WANG	SCHWANN CELL DERIVED EXOSOMES IMPROVE DIABETIC PERIPHERAL NEUROPATHY IN TYPE II DIABETIC MICE	NIDDK
GANESA WEGIENKA	EPIDEMIOLOGY OF ALLERGIC DISEASE ENDOTYPES	NIAID
GANESA WEGIENKA	ENVIRONMENTAL RISK FACTORS FOR UTERINE FIBROIDS: A PROSPECTIVE ULTRASOUND STUDY	NIEHS
KEOKI WILLIAMS	LEVERAGING ELECTRONIC MEDICAL RECORDS TO PERFORM LARGE-SCALE DIABETES PHARMACOGENOMICS	NIDDK
KEOKI WILLIAMS	COMBINED TRANSCRIPTOMICS AND GENOMICS TO FIND ASTHMA GENES IN ADMIXED POPULATIONS	NHLBI
YE XIONG	EXOSOME-BASED THERAPEUTICS IN TRAUMATIC BRAIN INJURY	NINDS
YENER NYENI	A CLINICALLY VIABLE NONINVASIVE METHOD FOR DIRECT MEASUREMENT OF MECHANICAL STRAINS IN VERTEBRAL BONE	NIAMS
LI ZHANG	COMBINATION TREATMENT WITH VEPOLOXAMER AND TPA FOR ACUTE STROKE	NINDS
ZHENG GANG ZHANG	EXOSOMES AND PLATINUM-INDUCED PERIPHERAL NEUROPATHY	NCI
ZHENG GANG ZHANG	AC-SDKP FOR TREATMENT OF ACUTE STROKE	NINDS
LI ZHOU	MICRORNAS REGULATE SKIN LANGERHANS CELLS	NIAMS

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