2015 Year in Review
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WHO WE SERVE

The Mass General Neurology Department consists of more than 300 physicians and scientists, all of whom have gained national and international recognition for their clinical and/or research efforts. We are united by a common purpose: finding new treatments and cures that will reduce and ultimately eliminate the devastating impact of neurological disorders.

During 2015, we cared for 42,000 patients across our ten clinical divisions. Patients come to us from as close as our own backyard and as far away as the other side of the globe. They span a broad range of socio-economic backgrounds, including age, ethnicity, sex, language, education, religion and special needs. They are met with a team—including physicians, researchers, nurses, medical support professionals and patient service staff—equally diverse and committed to improving the health of all individuals through informed patient care, recruiting practices and community outreach programs.

Community outreach programs include serving patients at our local community health centers located in Back Bay, Chelsea, Revere and Charlestown, and satellite locations including Waltham and southern New Hampshire. We have hosted programs to help patients navigate the complex health care system, reduce disparities and improve access to care for at-risk populations and the medically underserved, such as low-income families and the homeless.

These programs include:

- A monthly Neurology clinic at Boston Healthcare for the Homeless, hosted by our residents and faculty, who see and assist homeless individuals in the management of a wide variety of outpatient neurologic conditions, including seizures, movement disorders, stroke and headache;
- Education programs for community clinicians including seminars on common neurologic conditions provided free-of-cost to multicultural providers in Boston; and
- Partnerships with Mass General programs to develop youth from minority communities in Boston, including a stroke-focused education series for Boston Public School high school students participating in the Mass General Center for Community Health Improvement programs.
FROM THE CHIEF


This report highlights the innovations, successes and new initiatives celebrated in 2015. These initiatives are designed to strengthen and support our ambitious mission: to be the preeminent academic neurology department in the US by providing outstanding clinical care while rapidly discovering new treatments to reduce and eliminate the devastating impact of neurological disorders; to train the very best neurologists and scientists of the future; and to improve the health and well being of the diverse communities we serve.

LEADING IN BIOBANK RECRUITMENT
By enrolling Neurology patients in the Partners Healthcare Biobank—a large research program designed to help researchers understand how people’s health is affected by their genes, lifestyle and environment—we are better able to understand, treat and even prevent the diseases that might affect the health of future generations. In August of 2015, a full-time Biobank Coordinator joined the Department to focus on recruiting Neurology patients into the Partners Biobank. The efforts of the Biobank team have grown recruitment significantly, close to doubling the monthly totals in the last two months of Fiscal 2015.

ADVOCATING FOR RARE NEUROLOGICAL DISEASE COMMUNITIES
The Center for Rare Diseases (CRND), created by the Neurology Department in 2015, seeks to empower rare diseases and their communities by leveraging biological insights based on disease-causing genes, and facilitate early proof of concept studies and clinical trials. The CRND strives to become a leader in the field of rare diseases, creating new biological insights, alternate models of engagement and first trials in devastating disorders that have been underserved, as well as newly discovered neurological disorders lacking treatment.
2015 brought new developments in our ongoing quest to train the next generation of neurologists and scientists. Together with our Brigham and Women's Hospital colleagues, we implemented a Residency Certificate program, and graduated the first class of residents where seven residents received certificates. We initiated an online medical education case curriculum—a case-based virtual library to bridge the gap between theory and practice. Our Research Education Grants (R25) program continues to thrive with a 69 percent acceptance rate! We also organized and implemented a program for pre-medical students from diverse backgrounds, offering an introduction to Neurology through inpatient and outpatient shadowing, neuroscience lab experience and mentoring. Additionally, our Summer Student Neuroscience Series is now an established program, aiming to sustain passion and commitment to Neurology and the Neurosciences in undergraduate students from different Mass General Neurology labs.

Our momentum continues into 2016 where we will work to continue our efforts to bring research and clinical faculty closer together, create more access to our doctors for patients, and launch innovative new programs, including the Institute for Brain Health and the Center for Rare Diseases.

It’s a dynamic time in the field of neuroscience and I am excited to share with you in the pages that follow how these innovations and new initiatives will impact the future of healthcare in years to come.

Sincerely,

Merit Cudkowicz, MD, MSc
Chief of Neurology
The Behavioral Neurology Division provides comprehensive diagnostic and treatment services to patients with disorders of the brain affecting language, memory, problem solving and other intellectual functions, emotional function and behavior. The range of diseases seen is broad and includes stroke, degenerative disease, sub-acute dementias, traumatic brain injury, Attention Deficit Disorder (ADD), and Functional Neurological Disorders (FND). The Division has a weekly clinic, during which patients are seen by faculty, residents and fellows under faculty supervision. Complex cases are reviewed at a weekly case conference by a multidisciplinary group of providers from Psychiatry, Neuropsychology and other disciplines.

David Perez, MD, in his Functional Neurological Disorders Clinic.

“Many patients come in worried that they will not be heard; at our clinic, they learn that FND is a real neuropsychiatric condition, and if they meet the criteria, we can provide a clear diagnosis.”

DAVID PEREZ, MD
Director, Functional Neurological Disorders Clinic

BEHAVIORAL NEUROLOGY

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Within the Behavioral Neurology Unit at the Massachusetts General Hospital, Dr. David Perez, a board certified neurologist and psychiatrist, cognitive-affective neuroscientist and neuroimaging researcher, has established a new clinical and research initiative in Functional Neurological Disorders (FND). Patients with FND come to the clinic experiencing seizure-like events, abnormal movements, limb weakness and/or gait difficulties, yet traditional neurologic investigations don’t find a medical explanation for these symptoms. Doctors don’t see primary disruptions in motor brain pathways in these patients, nor do they uncover evidence of electrical seizures. Patients with these poorly understood functional neurological symptoms make up approximately 16 percent of referrals to neurology clinics. “These conditions are not rare. There’s a real unmet need,” says Dr. Perez. “By and large, experts in other neurologic and psychiatric conditions are ill-equipped as to how to help this group of patients.”

During an initial consultation at the FND clinic, Dr. Perez provides patients with concurrent neurological and psychiatric consultations. Working closely with colleagues in neuropsychiatry, neuropsychology, psychology, physical therapy, social work and the comprehensive neurology, epilepsy and movement disorder division, he develops an integrated and individualized “patient-centered” treatment plan that may involve physical therapy, cognitive behavioral therapy, or pharmacology, particularly if the patient is experiencing mood or anxiety symptoms. “Many patients come in worried that they will not be heard,” says Dr. Perez. “At our clinic, they learn that FND is a real neuropsychiatric condition, and if they meet the criteria, we provide a clear diagnosis.”

In parallel with the founding of the FND clinic, Dr. Perez established the Mass General Functional Neurology Research Group with a goal to use psychometric and other clinical characterization tools alongside advanced structural and functional magnetic resonance imaging (MRI) methods to identify clinical and neuroimaging biomarkers of symptom severity, prognosis and treatment response across the spectrum of FND. Patients who join the Mass General FND Clinical Research Cohort participate in longitudinal follow-up visits to collect additional psychometric data that will help the researchers learn who is responding to treatment and who is not.

The clinic and research group are unique in that they welcome patients with a wide range of functional symptoms. Traditionally, patients with psychogenic non-epileptic seizures would see an expert in epilepsy, while a patient with functional movement disorders might see a different specialist, and patients with limb weakness or gait troubles still other experts. The FND clinic’s novel, comprehensive approach pools resources for these patients and also recognizes that patients with FND may have commonalities despite their range of symptoms.

For instance, early research suggests that cortical hubs, regions of the brain where emotional, sensory, cognitive and motor information converge, may be the seat of disruptions that result in FND symptoms. More research is necessary, so Dr. Perez and his research group are following up with comprehensive neuroimaging in collaboration with colleagues at the Mass General/ Harvard-MIT Division of Health Sciences and Technology (HST) Athinoula A. Martinos Center for Biomedical Imaging. “Our research group is dedicated to understanding the biology of this very poorly understood neuropsychiatric condition,” says Dr. Perez.

The neuroimaging research includes the application of quantitative structural neuroimaging techniques to characterize brain structure alterations across the spectrum of FND. Imaging methods include cortical thickness, voxel-based morphometry and diffusion tensor imaging analyses. In parallel, the ongoing collection of Blood-Oxygen-Level-Dependent resting-state functional connectivity data will reveal functional alterations that may contribute to the understanding of FND. Future investigations will couple clinical and neuroimaging characterizations with treatment modalities to specifically investigate neural mechanisms and biomarkers of treatment response.
The Division of Clinical Neurophysiology includes the Mass General Epilepsy Service, the Mass General Sleep Medicine Program, the Intraoperative Neurophysiology Unit, the Mass General Epilepsy Monitoring Unit, the Mass General EEG Laboratory, the Mass General Evoked Potentials Laboratory, the Long-Term Monitoring Program and the Mass General Sleep Laboratory. Clinical programs in the division offer evaluation and management using the most advanced techniques available to children and adults with epilepsy and related disorders, sleep disorders, and disturbance of consciousness in a setting focused on the advancement of knowledge. Patients seen in this environment benefit from the input of multiple physicians and investigators that arises directly from our academic medical approach to evaluation and management and from our close integration with investigators across the spectrum of basic, translational and clinical research. Specific research programs range from genetic studies of rare epilepsy syndromes through multi-scalar neurophysiological recordings of humans to first-in-man studies of novel agents for the treatment of serious diseases, such as status epilepticus.

**FY15 Patient Volume**

6,364*

**FY15 Percentage of New Patients Seen**

29%

**FY15 TeleNeurology Visits**

122

*Outpatient clinic data only—does not include lab services

*A Clinical Neurophysiology Technologist applies electrodes at the beginning of an outpatient EEG exam.*
New imaging technologies have been a game changer in epilepsy diagnosis. We have developed very specific epilepsy imaging protocols and know how to analyze imaging modalities to optimize the chances of finding a cause. It’s now possible to identify lesions and disorders of brain development that are not obvious in routine scans,” says Dr. Cole.

This more precise imaging has changed outcomes for many patients like Elton. One longtime patient, a young lawyer with left temporal lobe seizures that were not adequately controlled, was initially rejected as a candidate for surgery because his low-grade tumor was located in the left frontal operculum and insula, areas of language cortex that are typically off limits due to concern for language function. The development of diffusion tensor imaging which allows assessment of white matter tracts connecting anterior and posterior speech areas, much of it at the Mass General Martinos Center for Biomedical Imaging, allowed the epilepsy team to reconsider surgery. DTI in this man clearly demonstrated that critical white matter tracts were displaced by the tumor, allowing surgery to remove the tumor without causing disconnection of language cortex and a resultant conduction aphasia. Following surgery, his seizures have been greatly reduced in both frequency and severity.

**THE MASS GENERAL EPILEPSY SERVICE—WHERE COMPLEXITY MEETS INNOVATION**

When Elton, a young Albanian architect, couldn’t find treatment for his disabling seizures in Albania, he traveled 500 miles to Austria to meet with Clinical Neurophysiology Division Chief Andrew J. Cole, MD. Dr. Cole, in Austria on a business trip, felt Elton was a good candidate for surgery and brought his case back to his colleagues in Boston.

After sophisticated imaging revealed a lesion in Elton’s left temporal lobe, Dr. Cole and a clinical team of epileptologists, neuroradiologists, neurosurgeons and neuropsychologists recommended a resection. Because the lesion was in the dominant hemisphere, decision making around whether to include the adjacent hippocampus in the resection was complicated. “Many specialists are involved in every case and bring greater insights and knowledge than any single practitioner can offer,” says Dr. Cole. Ultimately after careful mapping of language and memory function using functional MRI and Magnetoencephalography, intra-operative hippocamapgraphy, a technique pioneered at Mass General was used to guide the decision to spare the hippocampus.

Six months post-surgery, Elton is back in Albania and seizure-free. “With epilepsy surgery, we don’t declare victory for at least a year, but his seizures have stopped and his prospects look favorable,” says Dr. Cole.

**ADVANCED CARE FOR ALL PATIENTS**

Certified by the National Association of Epilepsy Centers as a Level 4 center—defined as having the capabilities to provide the most intensive testing, more extensive treatment and complex epilepsy surgery procedures—the Mass General Epilepsy Service can address the most complex, challenging cases. “We live by the motto ‘if you don’t get an answer here, you won’t get it anywhere,” says Dr. Cole.

**FUTURE PROSPECTS HOLD PROMISE**

In recent years, a number of new epilepsy medications have been approved and others are undergoing clinical trials. Most recently, the NeuroPace implanted responsive neural stimulator (RNS) device received FDA approval based on a multicenter clinical trial in which Mass General enrolled 8 patients. In the coming years, Dr. Cole expects “continued progress, with improvements in diagnosis, the development of new drugs and devices, and insights from scientific research, especially genetics, reshaping how we think about the disease.”
The Comprehensive Neurology Division is a team of sixteen expert physicians, guided by Division Chief Dr. Nagagopal Venna. Proficient in a wide-range of neurologic disorders, faculty also have areas of specialized expertise including neuromuscular neurology, multiple sclerosis and related disorders, movement disorders, headache disorders, autoimmune neurological disorders, neuroinfectious diseases and neuro-ophthalmology.
This year, the Comprehensive Neurology Division served as a testing ground for innovations in the outpatient setting. The resulting Comprehensive, Accessible, Neuro Diagnostic Unit (CANDU)—a practice developed to improve access for patients to the most appropriate level of neurologic care—is proving to transform care across divisions.

The triage unit plays a key role in the functioning of the CANDU by determining if a patient needs direct referral to a subspecialty division, and if that division can see the patient within three weeks. If the subspecialty appointment is not available in that time frame, the patient is offered the earliest possible appointment in the CANDU. In this case, one of our comprehensive neurologists serves as a gateway to more specialized, disorder-specific care. In addition, since the CANDU is the home of our most effective diagnosticians, individuals who present with complicated symptoms or diagnostic uncertainty are scheduled directly into this unit.

The CANDU is comprised of six neurologists, a registered nurse and patient care services staff. The clinicians work closely with colleagues in the subspecialty divisions to manage patients with known diagnoses who do not need subspecialty care, or to seamlessly transfer their care into a subspecialty division for more intensive, disorder-specific evaluation or management. Since many of the neurologic, diagnostic challenges encountered are in the area of neuro-infectious, neuro-rheumatologic and immunologic diseases, we are fortunate to have CANDU clinicians with specialized knowledge in these areas.

CANDU clinicians are also available for TeleNeurology consultation and often perform virtual visits with their patients using telemedicine. The CANDU is also the primary provider of eConsultation in which relatively straightforward questions are answered through formal chart review and documentation as a service to non-neurology providers in the Mass General community.

NEW INNOVATIONS: AUTOIMMUNE-AUTO INFLAMMATORY NEUROLOGICAL DISORDERS CLINICS

A Neuro-Infectious Disease subspecialty was initiated with the inception of the Neuro-Infectious Diseases Clinic at Mass General in 1998, in close collaboration with the Infectious Diseases Department, under the direction of Dr. Venna, with Dr. Tracey Cho as Associate Director. Recently, a clinician-investigator with a focus on Neurology of HIV infection, Dr. Shibani Mukerji, joined the division. In addition to her general neurology practice, she is developing several clinical research projects with interdisciplinary cooperative efforts.

A sample of the current research projects in this field include:

- Next-Generation Pathogen Sequencing for Meningitis and Encephalitis of Unknown Etiology with investigators Tracey Cho, Shibani Mukerji, Pardis Sabeti, Marcia Goldberg, Anne Piantiadosi and Jacob Lemieux.
- Developing neuroimaging biomarkers using ultra-high field 7T MRI, and MRI-PET for early identification of neurocognitive impairment and gut dysbiosis in chronic HIV infection with investigators: Cristina Granziera (Martinos), Shibani Mukerji (Neurology), Doug Kwon (Ragon)
- A Randomized, Double-Blinded, Placebo-Controlled Trial Comparing Antiretroviral Intensification With Maraviroc and Dolutegravir With No Intensification or Intensification With Dolutegravir Alone for the Treatment of Cognitive Impairment in HIV
- ACTG trial; MGH co-site leaders: Raj Gandhi and Shibani Mukerji

FELLOWSHIP IN ADVANCED/AUTOIMMUNE NEUROLOGY AT MASS GENERAL

The Fellowship in Advanced Auto Immune Neurology at Mass General has gained recognition and interest amongst new neurology trainees, growing from its inception in 1998 to three fellows annually. The fellowship clinics are supervised by Dr. Venna and Dr. Cho, and have helped in the diagnosis and care of complex neurological disorders with emphasis on autoimmune-mediated and auto-inflammatory neurological disorders.
MEMORY DISORDERS

The Memory Disorders Division is a group of neurologists and geriatric psychiatrists who see patients with dementia or concerns about their memory. It serves as a clinic in which every physician, and every patient, participates in research. The research projects range from systematic natural history, imaging, and biomarker programs to clinical trials. An NIH funded Center of Excellence, the Alzheimer’s Disease Research Center (ADRC), takes the lead in research in which the patients participate, and further supports a longitudinal research cohort that follows normal elderly, individuals with early (nearly asymptomatic) memory complaints, and those with clear memory impairments. Additional genetic and laboratory studies are carried out in collaboration with a very well developed research group led by senior PhD faculty, and collaborative programs across departments (Psychiatry, Radiology, and Neuropathology). The ADRC also supports several clinical fellows as well as extensive community outreach, lectures, and summer institute programs of both domestic and international students.

FY15 Patient Volume
2,064

FY15 Percentage of New Patients Seen
27%

SNIFFING OUT PRECLINICAL ALZHEIMER’S DISEASE

Mark Albers, MD, PhD, is developing a set of simple but powerful tools that examine the cognitive processing of odors to screen for the very earliest stages of preclinical Alzheimer’s Disease. “Ultimately,” Albers says, “we are hoping to develop a test that would be noninvasive and cost-effective that could be given to essentially everyone over the age of 50.”

His research is directed at determining if smell can serve as a preclinical biomarker for those who are at high risk for conversion Alzheimer’s Disease. “This could be valuable for enrollment in prevention trials, and may also serve as an outcome measure over time, to determine if a drug is changing the course of the disease,” he says. Dr. Albers is an Assistant Professor of Neurology at Harvard Medical School and a researcher at the MassGeneral Institute for Neurodegenerative Disease (MIND).
It has been known since the 1970s that the sense of smell declines with age, “but as in a lot of other areas of aging research, what we consider ‘normal aging’ is changing. It may be that decline of olfaction over time represents preclinical AD,” 10 or even 20 years before cognitive symptoms emerge.

The AD-related loss occurs very gradually, he says, and is rarely noticed by the patient. This has practical clinical implications: “Most people who are aware of a loss of sense of smell have a peripheral problem,” such as sinusitis. In contrast, about 90 percent of AD patients have diminished olfaction, but very few will report it.

“Olfaction may be particularly sensitive to Alzheimer’s Disease,” Dr. Albers says, since it involves two different regions of early AD pathology: the olfactory bulb, which is the first way station for olfactory information in the brain, and the entorhinal cortex, which receives input from the olfactory bulb and is a gateway to the hippocampus, the seat of episodic memory. Dr. Albers is exploring this circuitry in mouse models, examining the effect of known AD genes expressed solely in these areas. Among other results, he has found that the plaque-forming a-beta protein disrupts neuronal function and connectivity even before amyloid plaques accumulate, a finding with important implications for understanding AD pathogenesis.

THREE TESTS FOR THREE DISEASE STAGES
But multiple brain centers beyond the olfactory bulb and entorhinal cortex are likely involved in AD olfactory dysfunction, since smell identification includes not only a sensation, but association, recall and naming. In people, Dr. Albers uses three different odor tests to explore different aspects of olfactory deficits.

Patients with dementia, he says, have difficulty on the most basic task—determining whether two odors, presented in a single session separated by a minimal delay, are the same. Normal subjects and those with mild cognitive impairment (MCI) perform this task with relative ease, but it presents challenges for a person with dementia.

A harder task is odor identification. We all recognize certain smells, such as citrus or cinnamon, but finding the appropriate name can be difficult. “There are no direct connections between the olfactory processing centers and the language centers,” Dr. Albers says, “so it’s too hard to name a smell if you give the odor with no verbal cues.” In the test, therefore, the subject is asked to choose the name of the odor among four possible choices. Those with normal cognition do well on this test, but many with MCI do not.

An even harder test is called the “perception of odor episodic memory screen,” or POEMS, which combines elements of odor identification with a test of episodic memory. “We are finding that patients with dementia do poorly, as you would expect. But 25% of cognitively normal subjects are performing at the same poor level as AD patients.” Dr. Albers will now be following these individuals over time to see if they are at higher risk for developing AD. Those most at risk for AD might then undergo neuroimaging to assess their burden of plaques and tangles, and when treatment becomes available, begin anti-amyloid therapy.

“Olfaction is unique among our five sensory modalities, because there is a lot of plasticity embedded into the neural circuit dedicated to olfaction,” notes Dr. Albers, a function of the vast but unpredictable array of odors to which we may be exposed over the lifetime. That plasticity likely makes the odor circuitry, like the higher centers of the brain, vulnerable to the ravages of AD. “It may be that Alzheimer’s Disease is going to turn out to be one of the unfortunate consequences of all the wonderful things our brains can do.”
The mission of the Movement Disorders Division is to provide accurate diagnoses and continuing care for patients with movement disorders, and to conduct research into the etiology and pathomechanisms of each disorder. The ultimate goal of investigators in the Division is to develop effective treatments to improve symptoms, slow progression and eventually cure disease. To this end, each sub-unit is organized vertically, with dedicated basic science research in tandem with clinical care. In this model, discoveries in the laboratory can drive initiatives in clinical care, and clinical observations may spur new directions in basic research. An important reason for the success of this arrangement is that most of the clinicians in the Movement Disorders Division are also engaged in either clinical or basic science research. This fact enables seamless coordination of effort within each sub-unit, and minimizes the lag between novel discovery and transition to novel therapy.
Parkinson’s disease sharing ideas with their counterparts in Alzheimer’s disease, Huntington’s disease, and others, “to pick up clues that would have been much harder to identify if we were all working in isolation.”

AMYLOID IN PD PREDICTS COGNITIVE DECLINE

Dementia in the context of Parkinson’s disease is too often overlooked, according to John Growdon, MD, Professor of Neurology and Movement Disorders Division Chief at MassGeneral. “In the past, Parkinson’s disease has always been viewed as a primary motor disease, but information has emerged that about 80 percent of people with PD are demented at the time they die.” Despite the significance of dementia in the disease, motor symptoms have remained the focus of most treatment research. Dr. Growdon has worked to call attention to dementia in PD, and to figure out why it is so common.

Different pathologies coexist with the alpha-synuclein-containing Lewy bodies that are characteristic of PD. Whether these other pathologies are “part and parcel of the disease, or are additional hits, is unknown,” Dr. Growdon says. For instance, he notes, the majority of PD patients with dementia have amyloid pathology at autopsy.

To determine what the implications of amyloid in PD might be, he and his colleagues prospectively imaged amyloid with a PET brain scan in a group of non-demented PD patients over several years. They found that baseline amyloid predicted cognitive worsening over time, without any effect on motor decline, suggesting that amyloid pathology is operating independently. “The practical consequences of this observation are that whatever anti-amyloid therapies work that are being developed primarily for Alzheimer’s disease—a very big and active area for many pharmaceutical companies—will have immediate relevance to PD,” Growdon says.

Another protein, called tau, also accumulates in brains of Parkinson’s patients who develop cognitive impairment and dementia. Using another PET scan radioligand that detects abnormal amounts of tau, a new project is underway to determine whether tau accumulation influences cognitive impairments independently of amyloid in non-demented Parkinson’s patients. Advances in understanding the clinical effects of these two proteins will be critical to success in fashioning specific treatments for dementia in Parkinson’s disease.

CAN RAISING URATE PROTECT AGAINST PARKINSON’S PROGRESSION?

Michael Schwarzschild, MD, PhD, doesn’t want to give anyone gout. But he does want to know if raising blood urate—a risk factor for gout—can delay the progression of Parkinson’s disease. “It is a bit heretical,” he admits, but epidemiologic studies have shown conclusively that people with higher-than-average urate are at reduced risk for developing Parkinson’s disease. His team then conducted similar observational studies in people already diagnosed with Parkinson’s. Sure enough, they found that patients with higher urate levels did not worsen as quickly as those with lower urate. Together with lab evidence that urate can protect brain cells, these predictive ‘biomarker’ findings in humans raise the possibility of targeting urate could slow the progressive decline in Parkinson’s patients. “We are now asking whether, rather than just observing better outcomes with higher urate, can we actually prevent worsening by raising urate levels?” he says. Dr. Schwarzschild, a member of Mass General Institute for Neurodegenerative Disease (MIND) and Professor of Neurology at Harvard Medical School, with colleagues in the Parkinson Study Group, an international research consortium, is conducting an intervention trial, to see if raising urate slows worsening of patients’ symptoms over years. Starting in 2016 patients with early PD not yet requiring medication will be enrolled to receive placebo or inosine, a urate precursor, at 60 centers across the US. The strength of MIND, Dr. Schwarzschild says, is its interdisciplinary make-up, with molecular neurobiologists such as himself collaborating with epidemiologists and geneticists, and specialists in
The Mass General Hospital TeleNeurology program started as a small, acute stroke-focused pilot at Martha’s Vineyard Hospital, and has grown into one of the largest academic TeleNeurology networks in the nation. It provides access to neurological care for 6.5 million New Englanders, spanning all neurological conditions. The program allows for consultations at patients’ homes and at 30 community hospitals in all settings, including emergency rooms, critical care units, inpatient wards and ambulatory offices.

SPOTLIGHT ON: INNOVATION

Over 50 outpatient Mass General neurologists have conducted more than 700 virtual visits, reducing follow-up visits by an estimated 33 percent and freeing clinic time for new patients.
Among TeleNeurology services, TeleStroke and Emergency TeleNeurology continue to be the largest and most widespread. These programs have increased the use of thrombolytics to six over times the national average for the community hospitals that receive acute stroke coverage through the program, while avoiding unnecessary and costly inter-hospital transfers in over seventy percent of consults. We estimate the latter translated to more than $5 million in retained reimbursements for partnering community hospitals in 2015.

Non-acute TeleNeurology is a younger program that is growing at a rapid rate. The shortage of access to neurology expertise that most suburban and rural communities face also affects the ability for their local hospitals to manage non-emergency conditions locally, and to provide continuous care to patients suffering from common chronic conditions, including Parkinson’s and Alzheimer’s diseases. This program has allowed greater than 95 percent inpatient retention, again avoiding high cost transfers through scheduled consultations that keep the local provider closely involved in the process and the patient local.

Through these programs, Mass General TeleNeurology also puts great effort in the development of local capacity and performance improvement, through a virtual, continuing medical education platform, education symposia and events, and dedicated resources for regular program reviews, quality initiatives and site visits.

More locally, with the increased pressures of reducing costs while improving access and quality of care, Mass General has made an institutional investment in the development of TeleHealth programs for its own patients. The department of Neurology has been a pioneer in providing follow up consultation via videoconference technologies that allow patients to visit with their Neurologists from their location of choice, most frequently their home or their workplace. Patient satisfaction with the TeleNeurology Virtual Visits program is north of 90 percent, with a vast majority of patients rating their virtual visit as an experience comparable to their regular office visit. Over 50 outpatient Mass General neurologists have conducted more than 700 virtual visits, reducing follow-up visits by an estimated 33 percent and freeing clinic time for new patients. ALS patients, for example, are now seen at home, allowing care when clinic travel is no longer possible. Epilepsy patients that may not be able to drive to their appointments are now frequently receiving their care in the same way. TeleNeurology complements traditional care models with a systematic reduction of barriers. We are fully committed to empowering patients and communities through swift and convenient technology-supported access to our expert faculty.
PARTNERS NEUROLOGY RESIDENCY PROGRAM is the largest neurology training program in the country, with 18 adult and 2 pediatric neurology residents per year. In addition to the residency, Mass General hosts 12 accredited fellowships with nearly 50 neurology fellows currently in training. Mass General also serves as a teaching hospital for Harvard Medical School, with more than 50 students learning neurology through our services and clinics each year.

*From right to left, Shirley Wray, MD, PhD, Professor of Neurology, Comprehensive Neurology Division, with Anand Viswanathan, MD, PhD, Assistant Professor of Neurology, Stroke Division, discuss a case with fellows and residents during Chief’s Rounds.*
In the past academic year, our program has continued to innovate with the introduction of four new certificate programs: Medical Education; Quality/Safety; Global and Humanitarian Health; and Neuroscience Research. Through these optional programs, our trainees can access additional resources and expertise, while developing and implementing a scholarly project. We graduated the first class of residents who participated in these programs, with seven residents receiving 10 certificates.

Our program continues to have outstanding success with the NIH sponsored R25 grant program, with an acceptance rate of 69 percent. Currently we have six adult and one pediatric neurology residents who were awarded this grant, the largest of any institution nationwide.

We are currently developing an online virtual case curriculum to share the broad array of cases and clinical expertise of the Partners program more broadly, to help connect residents and faculty, and to train our residents in educational curricular excellence. We hope that this resource, which will continue to grow with each residency class, will help trainees domestically and abroad learn from the vast clinical experience of our institution.

We have also worked on recruitment into the neurosciences among high school and undergraduate students from diverse backgrounds. In 2015, our diversity committee, in conjunction with two of our residents, implemented a program for premedical student to visit the department and the hospital, mentoring them on education projects that they can present to their peers and community. We have continued to grow our summer student neuroscience series, which uses engaging presentations from a variety of clinical and scientific faculty, to give summer students a broad exposure to topics and careers in neuroscience.
NEUROCRITICAL CARE

Staff of the Division care for patients with the most severe acute injuries of the central and peripheral nervous system, including traumatic injuries, brain hemorrhage, cerebrovascular disease, coma, severe weakness, seizures, infections and inflammation. We care for patients in the Neuroscience Intensive Care Unit, in the Emergency Department, in the intensive care units of the hospital and remotely via video and telephone links to approximately 40 emergency departments in Massachusetts, New Hampshire and Maine.

Over the past five years the Division has grown to become the nation’s leading and largest Division of Neurocritical Care. Our faculty is unique in our dedication to both outstanding clinical care and outstanding research. We are consistently the country’s leading recipient of federal research funds and host the nation’s oldest, largest, and most distinguished fellowship training program in Neurocritical Care. Graduates of our Neurocritical Care Fellowship have, as a group, secured more federally-funded mentored research (K) awards than the alumni of all other Neurocritical Care programs combined.

A brain scan displays edema in a patient who needed decompressive craniectomy surgery.
INNOVATION IN BRAIN EDEMA TREATMENT

Brain edema, or brain swelling, is a common clinical problem encountered in patients who are treated in the Neuroscience Intensive Care Unit (Neuro ICU). It occurs in the setting of several types of acute brain injury, including traumatic brain injury, brain hemorrhage and ischemic stroke. Current management benefits from the expertise of a dedicated neuroscience intensive care. Treatments include mannitol or other osmotherapy to treat elevated intracranial pressure and mass effect. Neurosurgical procedures, such as emergency hemicraniectomy and ventriculostomy, are also used when brain edema becomes life-threatening.

In spite of these interventions, there is great need for improvement in treatment options.

W. Taylor Kimberly, MD, PhD, Associate Director of the Neurocritical Care Division, leads a research group that focuses on understanding the mechanisms of brain edema, as well as clinical trials designed to prevent its formation. “There are several exciting candidates under development for the prevention of brain edema,” Kimberly explains. “Our strategy is to design and implement rigorous multicenter clinical trials and apply imaging biomarkers based on mechanism of action to identify promising candidates to carry forward into phase III trials.”

In order to guide the development of clinical trials in brain edema, a major focus of the Kimberly research group is to understand the underlying mechanisms of injury associated with brain edema. Kimberly and colleagues have developed and implemented novel neuroimaging methods that quantify brain swelling, and have used these methods to investigate how this leads to impaired neurological recovery after stroke. These studies have highlighted that brain edema is an attractive therapeutic target in a broad range of stroke patients.

In order to improve patient outcomes, Kimberly has also led multidisciplinary teams that collaborate on brain edema. In that capacity, Kimberly has served as the National co-PI on the GAMES-RP trial, a multicenter, randomized, double-blind, placebo-controlled phase II clinical trial that evaluated intravenous glyburide for the prevention of brain edema after stroke. Conducted across 18 leading academic centers throughout the U.S., the analysis of both intermediate and clinical outcomes has provided important evidence of efficacy.

Looking toward the future, Kimberly is the International co-PI on a phase III trial for intravenous glyburide (GAMES-3 trial). This exciting development offers the promise to reverse the course in these potentially devastating disorders.

“Our hypothesis is that malignant edema is the tip of the iceberg,” Dr. Kimberly said, adding that the goal is to “move from reactive treatments that have had only modest effect to novel medications that prevent brain edema from occurring in the first place. We are now in the position to definitively test efficacy in a phase III trial and also begin plans for testing the drug in other acute brain injuries with brain edema.”

“The goal is to move from reactive treatments that have had only modest effect to novel medications that prevent brain edema from occurring in the first place.”

W. TAYLOR KIMBERLY, MD, PhD
Associate Director, Neurocritical Care Division
NEUROMUSCULAR DIVISION

The Neuromuscular Division at Mass General provides excellent care for a broad range of diseases focused on the peripheral nervous system, specifically muscle disorders including muscular dystrophies, myotonic disorders, inflammatory myopathies, congenital myopathies and metabolic myopathies; neuromuscular junction; nerve and acquired neuropathies; and anterior horn cell. The Neuromuscular Divisions hosts a leading multidisciplinary clinic and translational research program in Amyotrophic Lateral Sclerosis (ALS)/Motor Neuron Disease (MND) and has built specialty clinics/programs in Charcot-Marie-Tooth (CMT), Pediatric Neuromuscular, Myotonic Disorders and Myasthenia. Of note, the growing CMT program has recently joined the international CMT consortium.

Neuromuscular research at Mass General encompasses a broad array of clinical and translational research projects. ALS/MND is a particularly active area of investigation, and at the same time the Division is replete with numerous therapeutic trials, biomarker studies and translational pathophysiology investigations for a variety of diseases, including myasthenia, diabetic neuropathy, inflammatory neuropathy, hereditary neuropathy, and inclusion body myopathy.
To define such a biomarker, Atassi and colleagues are using the PBR28, which binds to TSPO, a protein present in activated glia and a marker for brain inflammation. In a first study of PBR28 uptake in people with ALS, the researchers showed increased uptake of the PET ligand compared to healthy people. Localization of brain inflammation corresponded to the clinical presentation: people with limb onset ALS showed more uptake in the motor cortex, while those with bulbar onset, uptake was more pronounced in bulbar regions.

Tracer uptake was also related to function: people who had more tracer uptake, hence more glial activation, had lower scores on the ALS-Functional Rating Scale, the most common measure in clinical trials for ALS. Now, Atassi and colleagues are incorporating PBR28 scans into several small clinical trials of new anti-inflammatory treatments for ALS.

The early data suggest that PET scans could also accelerate the diagnosis of ALS. “If you look at any one scan, without being a radiologist or a neurologist, you can tell right away who has ALS and who does not,” says Atassi. His own work shows that currently it takes about 12 months on average for patients to be diagnosed, from the time of first symptoms. “This could be a way to reduce that diagnostic timeline and help with early diagnosis,” he said.

To help expand the use of the tracer, Atassi and his colleagues are leading a multicenter study of a second generation TSPO-PET ligand. The new tracer, GE-180, incorporates an isotope with a half life of nearly 2 hours, compared to 20 minutes for PBR28. That will make the technology more portable and easier to use. The new tracer works the same platform as FDG-glucose, a PET ligand that is already widely used in most hospitals. “We are thinking ahead in terms of how you can scale this up, and how to use it in multiple centers, both in the clinical setting and in clinical trials,” he says.

### FY15 Patient Volume
4,259

### FY15 Percentage of New Patients Seen
42%

### FY15 TeleNeurology Visits
114

**IMAGING INFLAMMATION**

PET scanning is giving Mass General researchers a whole new view of neurodegenerative diseases. Nazem Atassi, MD, is working with a novel PET tracer, one that can detect inflammation in the brains of people with ALS. Part of his motivation is to streamline clinical trials of candidate treatments with anti-inflammatory mechanisms.

Currently, trials for ALS are slow affairs, requiring hundreds of patients be followed for at least a year to see if the drug affects physical functioning or not. “These are very expensive studies, they take a very long time for both the patients and the researchers,” Atassi explains.

Having a biomarker for inflammation in the brain would allow a much more efficient trial. Starting with a much smaller group of subjects, researchers could look for a decrease in inflammation after a short course of treatment. Knowing that the medication entered the brain and acted as expected in terms of mechanism would give researchers more confidence to embark on a longer trial with more patients, Atassi says.

The technology could also help in choosing patients for trials “There might be a subset of patients where inflammation is driving the disease, and so are more likely to respond to inflammatory treatments,” Atassi says. Enriching for those patients may increase the chances of a positive result.

“We are thinking ahead in terms of how you can scale this up, and how to use it in multiple centers, both in the clinical setting and in clinical trials.”

NAZEM ATASSI, MD  
Assistant Professor of Neurology, Neuromuscular Division
NEURO-ONCOLOGY

The mission of the Neuro-Oncology Division is to provide accurate diagnoses and continuing care for patients with brain tumors or complications of chemotherapy, and to conduct research into the causes and treatments of tumors of the nervous system. The ultimate goal of investigators in the Division is to develop effective treatments that improve quality of life and extend survival for patients. Over forty investigators across seven departments are engaged in brain tumor research, mainly on the main campus in the Brain Tumor Research Laboratories located in Simches as well as in the Charlestown Navy Yard. The research themes in neuro-oncology include genomics, epigenetics, metabolomics, angiogenesis, oncolytic gene therapy, stem cell biology, circulating biomarkers (cells, exosomes, platelets), experimental Magnetic Resonance (MR) and (Positron Emission Tomography (PET) imaging and cancer-related neurotoxicology. An institutional brain cancer grant was awarded to Mass General in 2013, one of only five brain Specialized Program of Research Excellence (SPORE) grants in the United States.
NEURO-IMAGING HELPS UNRAVEL BIOLOGY OF BRAIN TUMORS
Non-invasive imaging of the brain has improved dramatically over the past three decades. Neuro-oncology researchers at Mass General have developed novel imaging techniques that can accurately measure tumor blood flow, tumor metabolism and white matter connectivity. Through a long-term collaboration with the Athinoula A. Martinos Center, researchers in the Pappas Center for Neuro-Oncology have identified MR perfusion as a predictor of optimal glioblastoma response to anti-angiogenic agents (Proc Natl Acad Sci, 2013); have developed MR spectroscopy to non-invasively detect and monitor IDH1-mutant gliomas (Sci Transl Med, 2012; J Clin Invest, 2013); and have developed a novel MRI technique for assessment of glioblastoma oxygenation status (Nat Med, 2013). These imaging biomarkers hold promise for identifying patients likely or not likely to respond to treatment.

MOLECULAR BIOLOGY OF GLIOMAS REVEALS UNEXPECTED COMPLEXITY
Decades of research support the concept of cancer as a genetic disease in which normal cells acquire sequential genetic mutations which lead to tumor formation. Researchers in the Pappas Center for Neuro-Oncology continue to explore the molecular basis for brain tumors by applying novel techniques to this challenging problem. Recent advances published by team members include the identification of genetic mosaicism in glioblastoma (Cancer Cell, 2011); use of single-cell RNA sequencing technologies to characterize diffuse glioma subtypes, providing a view of tumor heterogeneity at an unprecedented level (Science, 2014); characterization of a transcription factor program that governs stem cell phenotype in glioblastoma cells (Cell, 2014); identification of circulating glioblastoma cells (Cancer Discov, 2014), and discovery of divergent genetic evolution of brain metastases compared to the primary cancer (Cancer Discov, 2015).

DEVELOPING NEW TREATMENTS FOR BRAIN TUMORS
The primary goal of the Neuro-Oncology Division is to translate key discoveries from research laboratories into new therapies for patients with brain tumors. All members of the Division engage in translational research and coordinate clinical trials that are offered at Mass General. In addition, members are working to develop novel therapies for tumors that lack effective medical treatments. In particular, recent discoveries include the identification of effective, anti-angiogenic therapy for neurofibromatosis, type 2 vestibular schwannomas (N Engl J Med, 2009); identification of targetable genetic alterations in meningiomas (Nat Genet, 2013) and craniopharyngiomas (Nat Genet, 2014); identification of placental growth factor as a therapeutic target in medulloblastoma (Cell, 2013), and identification of a novel therapeutic target of IDH1-mutant gliomas (Cancer Cell, 2015).

TRAINING FUTURE NEURO-ONCOLOGISTS
Finally, the Neuro-Oncology Division remains committed to training the next generation of neuro-oncologists. The Mass General Neuro-Oncology program also holds the only NCI-sponsored, neuro-oncology specific K12 training grant in the United States. This training grant has catalyzed the careers of a number of faculty investigators currently in the program (Plotkin, Brastianos, Nahed, Curry, Gerstner, Arrillaga, Jordan).

“The primary goal of the Neuro-Oncology Division is to translate key discoveries from research laboratories into new therapies for patients with brain tumors.”

SCOTT PLOTKIN, MD
Associate Professor of Neurology, Neuro-Oncology Division Chief
Neurologists in the Pediatric Neurology Division are trained in the diagnosis and treatment of pediatric neurological disorders and diseases from the most common to the most rare. Our pediatric neurologists specialize in certain conditions and diseases within pediatrics, so children who become patients here are matched with experts who can best serve each child’s needs. These neurologists are also trained in Adult Neurology, and many are Principal Investigators conducting basic science and clinical research to advance the diagnosis and treatment of their chosen subspecialty. Our physicians comprise the majority of Pediatric Neurologists at the MassGeneral Hospital for Children.

NEUROGENETICS EXPERT KATHRYN SWOBODA, MD JOINS MASSACHUSETTS GENERAL HOSPITAL PEDIATRIC NEUROLOGY TEAM

Child neurology is at the forefront of the genetics revolution in medicine, says Kevin J. Staley, MD, Division Chief of Pediatric Neurology at Mass General. Genetics play a large role in neurological disease in children, Staley says, because many disorders that affect the way the brain develops and functions have genetic roots.

Making sure the revolution delivers maximum benefits to patients in the timeliest way is the mission of Kathryn J. Swoboda, MD, the new Director of Neurogenetics at Mass General. A national and international leader in the diagnosis and treatment of rare genetic diseases, Swoboda is one of just a handful of US physicians trained and board certified in both neurology and clinical and molecular genetics. With a foot firmly planted in each world, Swoboda will spearhead Mass General’s efforts to integrate new genetic approaches and technologies into the practice of neurology.

With recent advances in DNA analysis, sequencing a child’s exome today costs the same as an MRI scan. The technology for detecting potential mutations is now well-established, but using that information to make specific genetic diagnoses is the current challenge, says Staley. “We are very excited to have
Swoboda, who was previously at the University of Utah, says she was drawn to Mass General by the richness of the genetics community and an ongoing institutional commitment to world-class research in human genetics. "It’s very unusual for a hospital to be so invested in research—Mass General and Partners Healthcare have made a huge investment in genome sequencing and research to figure out how to relate disease to novel genetic variants, and how that fits into a future personalized approach to our neurology patients, and patients in general," she said.

Together with Partners’ Personalized Medicine Initiative and the Laboratory for Molecular Medicine, she cites ties to top genetics researchers and computing resources at the nearby Broad Institute and MIT. On top of that, the Mass General Neurological Clinical Research Institute (NCRI) offers a robust infrastructure for translating new research into clinical trials, and collaborating with the Boston-area biotech community. Then there is the sheer size of the neurology community at Mass General and nearby, and the chance to train and mentor the next generation of neurology leaders.

"All of these resources make this this a unique environment for a geneticist and a neurologist who wants to focus on how we going to use genetics to transform medicine. That’s what exciting for me," Swoboda says.

Swoboda, who was previously at the University of Utah, says she was drawn to Mass General by the richness of the genetics community and an ongoing institutional commitment to world-class research in human genetics. "It’s very unusual for a hospital to be so invested in research—Mass General and Partners Healthcare have made a huge investment in genome sequencing and research to figure out how to relate disease to novel genetic variants, and how that fits into a future personalized approach to our neurology patients, and patients in general," she said.

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"All of these resources make this this a unique environment for a geneticist and a neurologist who wants to focus on how we going to use genetics to transform medicine. That’s what exciting for me," Swoboda says.

Swoboda’s return to Mass General is a homecoming of sorts—after graduating from Northwestern University Medical School in 1990, she trained in neurology and pediatric genetics in Harvard Medical School and Boston Children’s Hospital before taking a research and clinical position in Utah. At Mass General, Swoboda will occupy the newly created Katherine B. Sims Chair in Neurogenetics at Massachusetts General Hospital. The chair was established to honor Sims, a pediatric neurologist and a pioneer in neurogenetics who founded one of the first DNA diagnostic labs focused on rare diseases. Today, Mass General is one of only a few hospitals that maintain an in-house diagnostic lab, and offers some tests that are not available anywhere else. Swoboda’s appointment ensures that the lab and its services will endure and adapt to the new, and rapidly changing, genetics landscape.
STROKE SERVICE

The physician faculty of the Mass General Stroke Service care for patients with complex cerebrovascular disease, in all phases of care from prevention to acute intervention and recovery. They care for strokes of all types, including ischemic and hemorrhagic stroke, which are due to a variety of causes such as atherosclerosis, infection, vasculopathy, inherited disorders and other rare causes. A comprehensive approach to care addresses the needs of young adults through the oldest old, with clinical and research collaborations across numerous divisions and departments, the Mass General Vascular Center, primary care practices and the Spaulding Rehabilitation Network. The faculty of the Neurocritical Care Division also hold appointments in the Stroke Service, and together through this collaborative partnership the Division delivers acute inpatient care under the Acute Stroke Service led by Dr. Rost, the C. Miller Fisher (CMF) inpatient vascular neurology service and Stroke Consult Service led by Dr. Silverman, and the TeleStroke Service led by Dr. Viswanathan which extends our stroke expertise to over 30 emergency departments in New England.
situations are so individual. Treatment should be individually tailored to best meet their needs and expectations," says Dr. Leslie-Mazwi. Team members often observe or participate jointly in each other’s procedures to ensure the maximum benefit of experience and collaboration, and to facilitate an evidence-based approach to adopting new and emerging technology.

**USING CT ANGIOGRAPHY AND MRI TO ASSESS ISCHEMIC STROKE PATIENTS**

Determining which ischemic stroke patients will benefit most from which therapy is a challenge. “Every patient who is eligible should receive the clot-buster drug IV tPA, but a percentage of these patients with major strokes will require an endovascular procedure to snare and extract the clot directly,” says Dr. Leslie-Mazwi. Mass General pioneered novel, non-invasive CT-based imaging methods to detect blockages in brain arteries and MRI to quantify the amount of brain tissue that is irreversibly injured during a stroke, and these techniques are now the standard of care used around the world. Mass General researchers helped to define the parameters that can identify patients who are disabled enough to warrant treatment but are still safe to treat with advanced techniques of blood clot extraction. “Our research has shown that patients with less than 70 cc of brain damage can make a good recovery. However, patients with more extensive damage rarely have a good outcome even if we are able to open the blocked blood vessel,” Dr. Leslie-Mazwi says.

**EXTENDING THE REACH TO IMPROVE STROKE CARE ACROSS THE NORTHEAST**

Mass General neurologists have also been leaders in developing methods for measuring and improving the quality of stroke care across the US, and for increasing the proportion of patients who can receive the clot-buster drug IV tPA. Through the world-renowned Mass General TeleStroke Network which was established in 2001, the Mass General Stroke Service can now extend its acute stroke expertise to serve a catchment area of 6 million patients presenting to over 30 emergency departments across the northeast 24 hours a day, seven days a week. “Time is brain,” says Dr. Leslie-Mazwi. “By partnering with spoke hospitals, Telestroke enables us all to accelerate treatment and save lives.”

Through cutting edge research, superb clinical training and outstanding clinical care, the Mass General Stroke Service continues the tradition begun by Dr. Fisher over 65 years ago with the ultimate goal of reducing the incidence and burden of stroke.

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**RESEARCH PROGRAMS WITHIN THE STROKE SERVICE**

The 22 faculty members of the Stroke Service conduct funded research across the full spectrum of translational research, under the overall guidance of Dr. Steven Greenberg who serves as the Research Integration Liaison for the Stroke Service and the site PI for the NINDS funded National NeuroNext and SPOTRIAS networks, Dr. Lee Schwamm who serves as the site PI of the Regional Coordinating Center for Massachusetts in the newly launched NINDS StrokeNet Network.

**SHIFTING THE NEUROENDOVASCULAR CARE PARADIGM**

Mass General was an early pioneer in the field of neuroendovascular care, and a strong advocate of the value of interdisciplinary care, with neurology, neurosurgery and neuroradiology faculty all working together to achieve the best patient outcomes. “The neuroendovascular field was once dominated by radiology. It has undergone a major paradigm shift in the last few decades and the Mass General Neuroendovascular faculty now includes physicians from neurology, neuroradiology and neurosurgery and trains fellows from all three disciplines. We’ve created a collaborative environment which promotes thoughtful, evidence-driven, and truly patient-centered care,” says Dr. Thabele Leslie-Mazwi, Director of Interventional Neurology in the Neuroendovascular program.

The neuroendovascular team meets weekly to discuss challenging patients with other physicians that deal with cerebrovascular disease, including Neurosurgery, Radiation Oncology, the Stroke Service and NeuroCritical Care Division, and decides as a group on the best treatment options for each patient. “Every patient’s problems, risk factors and social
“Our momentum continues into 2016 where we will work to continue our efforts to bring research and clinical faculty closer together, create more access to our doctors for patients, and launch innovative new programs, including the Institute for Brain Health and the Center for Rare Diseases.”

MERIT CUDKOWICZ, MD, MSc
Chief of Neurology
**2015 FACULTY**

**CLINICAL NEUROPHYSIOLOGY**

Andrew James Cole, MD  
*Division Chief, Clinical Neurophysiology*

Adusumilli, Josna, MD  
Instructor in Neurology (Sleep Unit)

Bianchi, Matt T., MD, PhD  
Assistant Professor of Neurology (Sleep Unit)

Cash, Sydney Samuel, MD, PhD  
Associate Professor of Neurology (Epilepsy Unit)

Chu, Catherine J., MD  
Assistant Professor of Neurology (Epilepsy Unit)

Cole, Andrew James, MD  
Professor of Neurology (Epilepsy Unit)

Herbert, Martha Reed, MD, PhD  
Assistant Professor of Neurology

Hoch, Daniel Brian, MD, PhD  
Assistant Professor of Neurology (Epilepsy Unit)

Kimchi, Eyal Y., MD, PhD  
Instructor in Neurology (Epilepsy Unit)

Klein, Max Mordecai, PhD  
Instructor in Neurology

Maus, Douglas, MD  
Assistant Professor of Neurology

Moura, Lidia Maria Veras Rocha de, MD, MPH  
Instructor in Neurology (Epilepsy Unit)

Pathmanathan, Jay S., MD, PhD  
Instructor in Neurology (Epilepsy Unit)

Sassower, Kenneth Clayton, MD  
Instructor in Neurology (Sleep Unit)

See, Reiner Henson B., MD  
Instructor in Neurology (Epilepsy Unit)

Simon, Mirela, MD  
Assistant Professor of Neurology (Epilepsy Unit)

Stakes, John Wilbur, MD  
Assistant Professor of Neurology (Sleep Unit)

Westover, Michael B., MD, PhD  
Assistant Professor of Neurology (Epilepsy Unit)

**COMPREHENSIVE NEUROLOGY**

Gopal Venna, MD  
*Division Chief, Comprehensive Neurology*

Bali, Taha, MD  
Instructor in Neurology

Bowley, Michael P., MD, PhD  
Instructor in Neurology

Caviness, Verne S., MD, Dphil  
Giovanni Armenise—Harvard Distinguished Professor of Neurology

Chen, David W., MD  
Instructor in Neurology

Chen, Xiqun, MD  
Assistant Professor of Neurology

Cheng, Hsinlin T., MD, PhD  
Assistant Professor of Neurology

Cho, Tracey Alexander, MD  
Assistant Professor of Neurology

Clark, Timothy William, PhD  
Assistant Professor of Neurology

Cohen, Adam B., MD  
Assistant Professor of Neurology

Das, Sudeshna, PhD  
Assistant Professor of Neurology

Grishchuk, Yulia, PhD  
Instructor in Neurology
Comprehensive Neurology Faculty continued.

Horowitz, Steven Howard, MD  
Assistant in Neurology

Hunt, Ann L., DO*  
Assistant Neurologist

Kastin, Bruce R., MD*  
Instructor in Neurology

Klawiter, Eric C., MD  
Assistant Professor of Neurology

Klein, Max Mordecai, PhD  
Instructor in Neurology

Lehrich, James Richard, MD  
Associate Professor of Neurology

Linnoila, Jenny J., MD, PhD  
Assistant in Neurology

Mateen, Farrah J., MD, PhD  
Assistant Professor of Neurology

Mejia Gonzalez, Nicte I., MD*  
Assistant Professor of Neurology

Moskowitz, Michael Arthur, MD*  
Professor of Neurology

Moura, Lidia Maria Veras Rocha de, MD, MPH  
Instructor in Neurology

Mukerji, Shibani S., MD, PhD  
Assistant in Neurology

Murphy, Shawn Norman, MD, PhD*  
Associate Professor of Neurology

Nair, Dinesh G., MBBS, PhD*  
Instructor in Neurology

Nicholson, Katharine A., MD  
Instructor in Neurology

Oaklander, Anne Louise, MD, PhD  
Associate Professor of Neurology

Parker, Stephen William, MD  
Assistant Professor of Neurology

Pasinski, Marie E., MD  
Instructor in Neurology

Reda, Haatem M., MD  
Instructor in Neurology

Saxena, Vishal, PhD*  
Instructor in Neurology

Sheikh, Sarah I., BMBCh  
Instructor in Neurology

Slaugenhaupt, Susan A., PhD  
Professor of Neurology

Wray, Shirley H., MD, PhD  
Professor of Neurology

MEMORY DISORDERS

Teresa Gomez-Isla, MD  
Co-Division Chief, Memory

Bradley Hyman, MD, PhD  
Co-Division Chief, Memory

Albers, Mark W., MD, PhD  
Assistant Professor of Neurology

Arbel, Michal, PhD  
Instructor in Neurology

Arnold, Steven E., MD  
Neurologist

Aronin, Neil, MD  
Clin Asc in Neuroendocrinology

Bacskai, Brian James, PhD  
Professor of Neurology

Berezovska, Oksana, PhD  
Associate Professor of Neurology

Bhattacharyya, Raja, PhD  
Instructor in Neurology

Byrne, Thomas Nilan, MD*  
Professor of Neurology and Health Sciences & Technology, Part-time
John Growdon, MD  
Division Chief, Movement

Fox, Michael D., MD, PhD  
Assistant Professor of Neurology

Frosch, Matthew P., MD, PhD  
Associate Neuropathologist

Gomperts, Stephen N., MD, PhD  
Assistant Professor of Neurology

Growdon, John Herbert, MD  
Professor of Neurology

Hendriks, Wilhelmus Theorus, PhD  
Instructor in Neurology

Herrington, Todd M., MD, PhD  
Instructor in Neurology

Hersch, Steven M., MD, PhD  
Professor of Neurology

Hung, Albert Y., MD, PhD  
Assistant Professor of Neurology

Isacson, Ole S., MD  
Professor of Neurology

Ito, Naoto, PhD  
Instructor in Neurology

Ito, Noriko, PhD*  
Instructor in Neurology

Kazantsev, Aleksey, PhD  
Associate Professor of Neurology

Kegel-Gleason, Kimberly Beth, PhD  
Assistant Professor of Neurology

Khurana, Vikram, MBBS, PhD*  
Assistant in Neurology

Li, Xueyi, PhD*  
Assistant Professor of Neurology

Locascio, Joseph Jasper, PhD  
Assistant Professor of Neurology

Macklis, Jeffrey D., MD*  
Professor of Neurology

Mejia Gonzalez, Nite I., MD  
Assistant Professor of Neurology

Mouro Pinto, Ricardo, PhD  
Instructor in Neurology

Myre, Michael Arthur, PhD  
Instructor in Neurology

Nery, Flavia Christina, PhD  
Instructor in Neurology

Ozelius, Laurie Jean, PhD  
Associate Professor of Neurology

Quinti, Luisa, PhD  
Instructor in Neurology

Reuter, Martin, PhD  
Assistant Professor of Neurology

Rosas, Herminia Diana, MD  
Associate Professor of Neurology

Sadri-Vakili, Ghazaleh, PhD*  
Assistant Professor of Neurology

Scharf, Jeremiah M., MD, PhD  
Assistant Professor of Neurology

Scherzer, Clemens Rudolf, MD  
Associate Professor of Neurology

Schmahmann, Jeremy, MD  
Professor of Neurology

Schwarzchild, Michael A., MD, PhD  
Professor of Neurology

Seong, Ihn Sik, PhD  
Assistant Professor of Neurology

Sharma, Nutan, MD, PhD  
Associate Professor of Neurology

Sohur, Usharbudh, MD, PhD  
Instructor in Neurology

Sudarsky, Lewis R., MD  
Associate Professor of Neurology

Suh, Jaehong, PhD  
Assistant Professor of Neurology

Vaine, Christine Adele, PhD  
Instructor in Neurology
Vanderburg, Charles R., PhD
Instructor in Neurology

Videnovic, Aleksandar, MD *
Assistant Professor of Neurology

Wang, Taowei David, PhD
Instructor in Neurology

Waugh, Jeffrey L., MD, PhD *
Assistant in Neurology

Wheeler, Vanessa Chantal, PhD
Associate Professor of Neurology

Wills, Anne-Marie A., MD, MPH
Assistant Professor of Neurology

Young, Anne Buckingham, MD, PhD
Julianne Dorn Professor of Neurology

Zhang, Can, MD, PhD
Assistant Professor of Neurology

NEUROCRITICAL CARE

Johnathan Rosand MD, MSc
Division Chief, Neurocritical Care

Anderson, Christopher D., MD *
Assistant Professor of Neurology

Edlow, Brian L., MD *
Instructor in Neurology

Hochberg, Leigh Robert, MD, PhD *
Senior Lecturer on Neurology

Kimberly, William T., MD, PhD *
Assistant Professor of Neurology

Leslie-Mazwi, Thabele M., MD *
Assistant Professor of Neurology

Musolino, Patricia L., MD, PhD *
Instructor in Neurology

Phuah, Chia-Ling, MBCh
Graduate Assistant

Rordorf, Guy A., MD *
Associate Professor of Neurology

Rosand, Jonathan, MD *
Professor of Neurology

Rosenthal, Eric S., MD *
Assistant Professor of Neurology

Schwamm, Lee H., MD
Professor of Neurology

NEUROBEHAVIORAL

David Caplan MD, PhD
Division Chief, Neurobehavioral

Campron-Gimenez, Joan A., MD, PhD
Assistant in Neuroscience

Caplan, David Norman, MD, PhD
Professor of Neurology

Gow, David Whitcomb, PhD
Instructor in Neurology, Part-time

Herbert, Martha Reed, MD, PhD
Assistant Professor of Neurology

Kastin, Bruce R., MD
Instructor in Neurology

Khurana, Vikram, MBBS, PhD
Assistant in Neurology

Massaquoi, Steve G., MD, PhD
Instructor in Neurology

Moo, Lauren Rachel, MD
Assistant Professor of Neurology

Mormino, Elizabeth Charlotte, PhD
Instructor in Neurology

Murray, Evan D., MD
Instructor in Neurology, Part-time

Perez, David L., MD *
Instructor in Neurology

Price, Bruce Heimburger, MD
Associate Professor of Neurology

Quiroz-Gaviria, Yakeel T., PhD
Instructor in Psychology in the Department of Psychiatry
Neurobehavioral Faculty continued:

Sadri-Vakili, Ghazaleh, PhD
Assistant Professor of Neurology

Schmahmann, Jeremy, MD
Professor of Neurology

Sperling, Reisa A., MD
Clinical Associate

Wang, Taowei David, PhD
Instructor in Neurology

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**NEUROMUSCULAR**

James Berry, MD
*Co-Division Chief, Neuromuscular*

Bill David, MD, PhD
*Co-Division Chief, Neuromuscular*

Atassi, Nazem, MD
Assistant Professor of Neurology

Balcioğlu, Aygul, PhD
Instructor in Neurology

Bali, Taha, MD
Instructor in Neurology

Berry, James D., MD, MPH
Assistant Professor of Neurology

Bowley, Michael P., MD, PhD
Instructor in Neurology

Chad, David A., MD
Associate Professor of Neurology

Cros, Didier Pierre, MD
Assistant Neurologist

Cudkowicz, Merit Ester, MD
Julieanne Dorn Professor of Neurology

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David, William S., MD, PhD
Associate Professor of Neurology

Dawson, Katherine Tkach, MD
Neuroscientist

Fridman, Vera, MD
Instructor in Neurology

Guidon, Amanda C., MD
Instructor in Neurology

Han, Steve S., MD, PhD
Instructor in Neurology

Hunt, Ann L., DO
Assistant Neurologist

Klein, Max Mordecai, PhD
Instructor in Neurology

Lagier-Tourenne, Clotilde, MD, PhD
*Pending—Assistant Professor of Neurology*

Lee, Lillian Villaruz, MD
*Research Scientist*

Macklis, Jeffrey D., MD
Professor of Neurology

Maguire, Casey Aaron, PhD
Assistant Professor of Neurology

Mouro Pinto, Ricardo, PhD
Instructor in Neurology

Nair, Dinesh G., MBBS, PhD
Instructor in Neurology

Nicholson, Katharine A., MD
Instructor in Neurology

Quinti, Luisa, PhD
Instructor in Neurology

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