

**NorthShore**  
University HealthSystem

**Neurological Institute**

Personalized Neurological Care

2016 ANNUAL REPORT

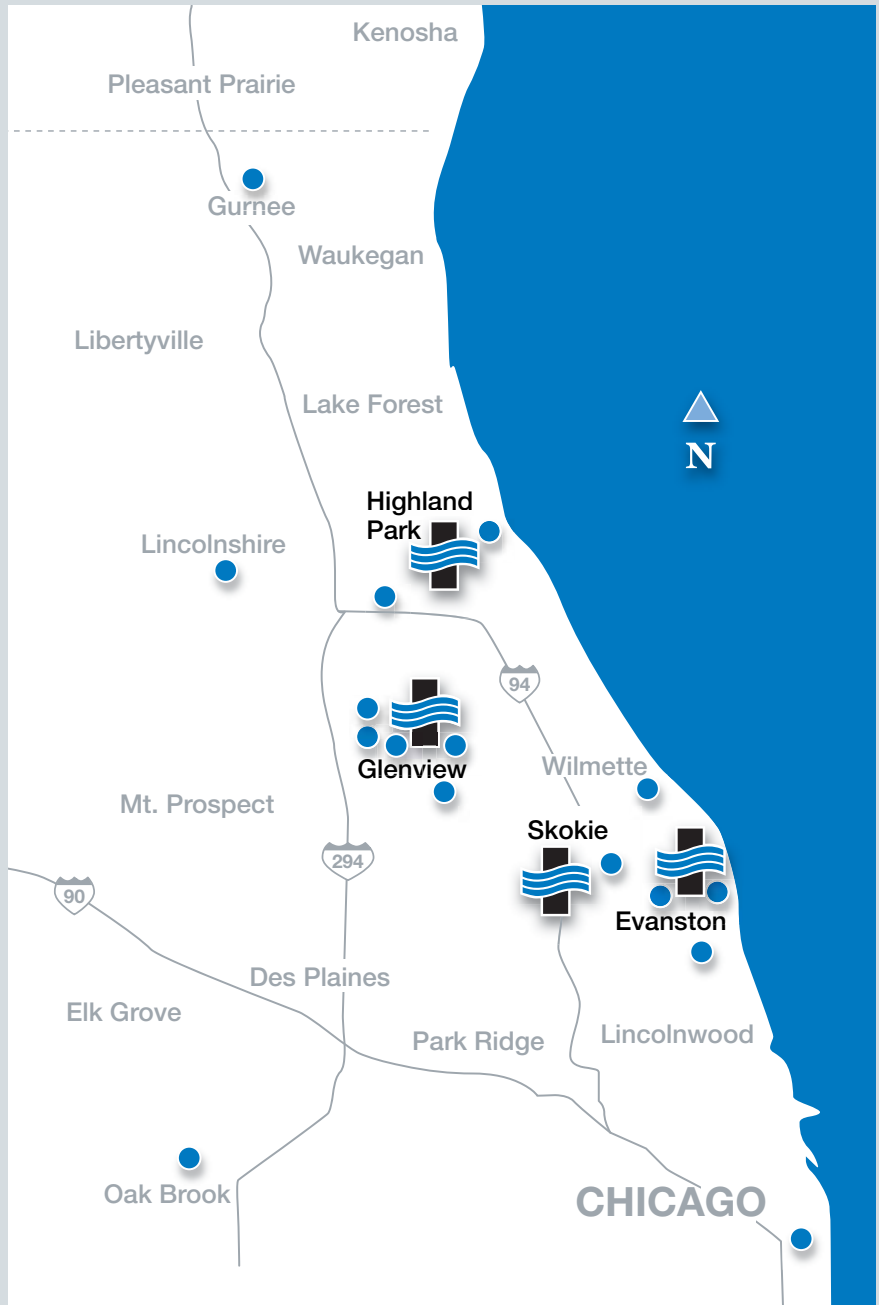




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**NorthShore University HealthSystem (NorthShore) Neurological Institute offers unparalleled access throughout the Chicago area, including at each of our four award-winning hospitals. Our expert team of neurospecialists offers comprehensive care for a wide range of neurological conditions.**



Call **(877) 570-7020** for more information or to schedule an appointment.

# Our Leadership

## **Demetrius M. Maraganore, MD**

*Ruth Cain Ruggles Chairman, Department of Neurology  
Medical Director, NorthShore Neurological Institute*

Dr. Maraganore is an internationally renowned expert on Parkinson's disease and other movement disorders. He has been recognized as one of the world's 20 most cited experts on Parkinson's disease in the 21st century (Aaron A. Sorenson landmark study, published in the inaugural issue of the *Journal of Parkinson's Disease*). A Chicago native, Dr. Maraganore attended Northwestern University Medical School and then left for neurology residency training at the Mayo Clinic. At Mayo, he joined the faculty, rose to the rank of Professor of Neurology and served as the Chair of the Division of Movement Disorders. At NorthShore, Dr. Maraganore's research leverages clinical excellence and expertise and an award-winning Electronic Medical Record (EMR) system. Dr. Maraganore is leading 11 longitudinal studies of neurological disorders, to include 1,000 patients each, with the theme of DNA predictions to improve neurological health. He is also the Principal Investigator of the Neurology Practice Based Research Network (NPBRN), a federally funded initiative to improve the quality of neurological care and to conduct comparative effectiveness and outcomes research using the EMR. Presently, 14 academic departments of neurology across the nation are participating in the NPBRN. Dr. Maraganore also serves as the Director of NorthShore's Center for Brain Health—an initiative to prevent Alzheimer's, Parkinson's and other aging brain disorders in healthy individuals. He was featured in 2016 as a "Chicago Top Neurologist" by *Chicago* magazine for this highly innovative work.

## **Joseph T. Alleva, MD, MBA**

*Chief, Division of Physical Medicine and Rehabilitation*

Dr. Alleva has spent his entire career at NorthShore since completing his specialty training in 1994 at the Rehabilitation Institute of Chicago (RIC), where he was chief resident. Dr. Alleva directs a team of physiatrists and therapists (physical, occupational, speech-language) experienced in treating patients with brain and spine disorders. Dr. Alleva holds an MD degree from the Chicago Medical School and completed an internship in internal medicine and neurology at Northwestern University Medical School. His expertise in the field most recently landed him on the "America's Best Doctors" list compiled by *U.S. News & World Report*, and for more than a decade, he has consistently been lauded in Castle Connolly Guide's *How to Find the Best Doctors in Chicago*. In 2011, *Chicago* magazine featured Dr. Alleva on its "Best Sports Medicine Doctors" list.

## **Julian E. Bailes, MD**

*Bennett-Tarkington Chairman, Department of Neurosurgery  
Surgical Director, NorthShore Neurological Institute*

Dr. Bailes is a nationally recognized leader in neurosurgery, with special emphasis on brain tumors and the impact of brain injury on brain function. He is also one of the first neurosurgeons in the Chicago area to use the minimally-invasive NICO BrainPath® as part of the Six Pillars approach, offering promising outcomes for patients with otherwise inoperable brain tumors using the most advanced imaging and intervention technologies. As a national authority in neurosurgery, Dr. Bailes is President of the Subcortical Surgery Group, neurological consultant to the NFL Players' Association (NFLPA), Medical Director of Pop Warner Football and an adviser to the NCAA. Dr. Bailes has been honored as one of the nation's best surgeons and recently has been recognized as a 2016 "Chicago Top Neurosurgeon" by *Chicago* magazine. Dr. Bailes' current research focuses on innovative new strategies for treating and preventing the impact of traumatic brain injury. His research has been instrumental in the understanding of the clinical evidence of chronic traumatic encephalopathy (CTE), a progressive degenerative disease found in individuals who have been subjected to multiple concussions and other forms of head injury. The research done by Dr. Bailes as it relates to the discovery of CTE in football players was featured in the movie *Concussion*.



*From left: Dr. Joseph Alleva, Dr. Julian Bailes and Dr. Demetrius Maraganore*

# About Our Institute

11 NorthShore  
Neurological Institute  
Specialists Listed  
as Castle Connolly  
"Top Doctors"

*U.S. News &  
World Report*  
"High Performing"  
in Neurology and  
Neurosurgery

Systemwide  
Magnet®  
Recognition by  
American Nurses  
Credentialing  
Center

Blue Distinction®  
Centers+ for Spine  
Surgery

Systemwide  
Certification by  
Joint Commission  
as Primary Stroke  
Center

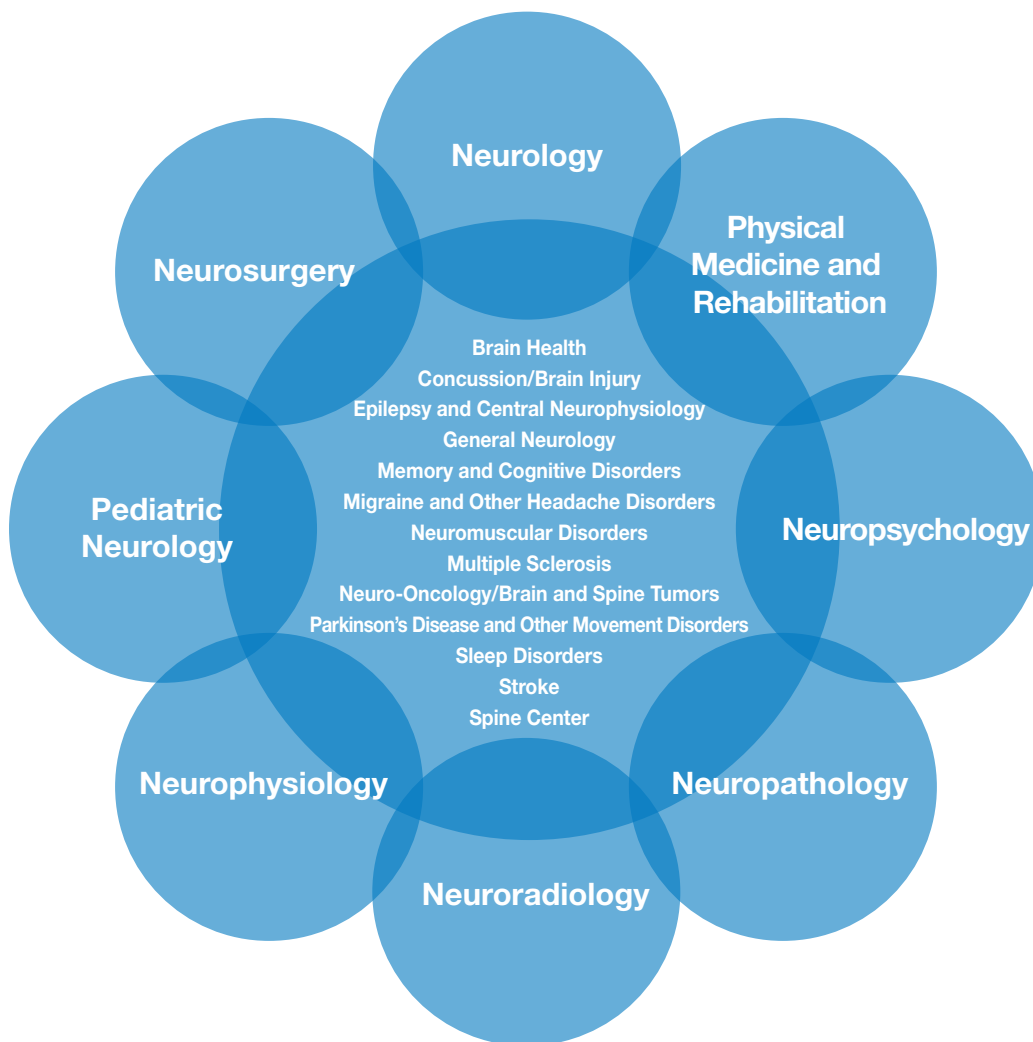
Designated Center  
for Comprehensive  
and Coordinated  
Multiple Sclerosis  
Care

Sleep Center  
Certification  
and A-STEP  
Accreditation by  
American Academy  
of Sleep Medicine

## A Personalized and Team Approach to Advanced Neurological Care

NorthShore Neurological Institute's comprehensive programs offer patients and their families proven expertise, advanced technology and outstanding care coordination to treat a variety of neurological diseases and conditions.

As one of the region's pre-eminent providers of neurological care, we are actively engaged in clinical trials and translational research. We regularly launch new research studies to ensure that the latest technology, clinical treatments and techniques are available for our patients.



The foundation of our excellence in neurological care is the personalized and multidisciplinary approach that is essential to achieving the best possible outcomes. Each program in the center circle has a team of medical, surgical and rehabilitative members with unique expertise that maintains open lines of communication. These members often collaborate face-to-face in real time, as well as through one of the most advanced Electronic Medical Record (EMR) systems in the country, to deliver care effectively for complex neurological diseases.

# Key Clinical Services

## Neuro-Oncology/Brain and Spine Tumors

- Complete diagnostic evaluation leveraging advanced neuroimaging and molecular neuropathology.
- Multidisciplinary care team that reviews each patient's case at regular tumor conferences and in consultation with the patient and family and develops a personalized treatment plan.
- Clinical trials, offering patients access to promising new methods of cancer detection and treatment.

## Parkinson's Disease and Other Movement Disorders

- Pharmacological management, patient education, rehabilitative services to optimize functional independence and improve quality of life.
- Deep brain stimulation (DBS), a surgical therapy used for the treatment of Parkinson's disease.

## Brain Health

- Clinical services for patients at higher risk of Alzheimer's, Parkinson's disease or chronic traumatic encephalopathy.
- Assessment of familial, genetic, lifestyle and comorbidity risks.
- Medical, physical, cognitive, dietary and integrative therapies to reduce risk.
- Annual visits to preserve and improve brain health, and to prevent dementia and other aging-related brain disorders.

## Memory and Cognitive Disorders

- Care team of neurologists, neuropsychologists, nurses and a medical social worker who embrace the highest standard of care, continuously seeking and offering new and innovative treatments, cutting-edge imaging techniques and neuropsychological evaluation tools.

## Concussion/Brain Injury

- A multidisciplinary and nationally recognized team of concussion and head injury specialists.
- Multipronged approach to the diagnosis and management of acute concussion, postconcussion syndrome and chronic consequences of brain injury.
- Sports Concussion Program with neurological and neuropsychological assessment.

## Neurosurgery

- Surgical intervention for disorders of the brain and spine by highly trained and specialized neurosurgeons using the latest technology for optimal patient outcomes.
- Minimally invasive procedures for epilepsy, neurovascular conditions and brain tumors of the skull base.
- One of the few centers nationwide to use the NICO 6 Pillar Approach for removing lesions and blood clots located deep within the brain.

## Epilepsy and Central Neurophysiology

- Complete diagnostic services to identify the likelihood and cause of seizures and assess the patient's candidacy for admission to our Epilepsy Monitoring Unit (EMU).
- Medication management and surgical options (for suitable candidates) that include laser interstitial thermal therapy, responsive neurostimulation and vagus nerve stimulation.

## Stroke

- Management of acute stroke, prevention of future strokes and post-stroke rehabilitation using a combination of medications; surgical interventions; physical, occupational and speech therapies; and lifestyle changes.
- Acute stroke team that is available 24/7 to make quick decisions regarding intravenous tissue plasminogen activator administration and/or minimally invasive intra-arterial interventions.
- Utilization of advanced telemedicine technologies to reduce door to needle or intervention times (best outcomes).



*Dr. Steven Meyers, Vice Chair of Quality, leads a team of specialists treating headache disorders with a wide variety of treatment options.*

## Migraine and Other Headache Disorders

- Evaluation of headache disorders by specialized neurologists in consultation with experts in psychiatry, psychology or neurosurgery to aid in the treatment.
- Chronic headache specialists who may recommend Botox® therapy, integrative medicine such as acupuncture and patient education to recognize triggers and modify habits.

## Spine Center

- Comprehensive nonsurgical pain management techniques.
- Advanced minimally invasive and complex surgical expertise.

*(continued)*



# Key Clinical Services

## Neuromuscular Disorders

- Diagnostic workups incorporating electromyography and an advanced Autonomic Laboratory.
- Amyotrophic lateral sclerosis clinic offering treatment modalities to optimize quality of life.

## Multiple Sclerosis

- Services at our designated Center for Comprehensive Multiple Sclerosis Care that begin with a diagnosis involving in-depth clinical, laboratory and neuroimaging evaluations.
- Treatments that use new “disease modifying” oral medications, and infusion therapies such as intravenous corticosteroids, plasma exchange and baclofen via intrathecal pump.
- Several active clinical trials that explore the efficacy and safety of new treatments.

## Sleep Disorders

- Two Sleep Laboratories accredited by the American Academy of Sleep Medicine.
- Staffed by one of the largest teams of board-certified sleep neurologists, pulmonologists and nurse specialists in Chicagoland.
- Full range of services including consultations, nocturnal polysomnograms and home sleep apnea testing.

## General Neurology

- Evaluation, diagnosis, treatment and management of a variety of acute and chronic neurological conditions such as pain, tingling, numbness, weakness, dizziness, passing out and problems with speech, vision, hearing, swallowing or balance/coordination.

## Physical Medicine and Rehabilitation

- Inpatient and outpatient rehabilitation plans that best help patients improve physical function and achieve rehabilitation goals.
- Fluoroscopic guided injection for spine pain, Sports Medicine Program that offers ultrasound guided peripheral joint injections and regenerative procedures, and specialized procedures including radiofrequency ablation and spinal cord stimulators.

## Pediatric Neurology

- Family-centered diagnosis and care for children with disorders of the brain and nervous system, such as headache and seizures.
- Close collaboration with the pediatrician, behavioral and developmental specialists, neuropsychologists, and clinical psychologists.

## Neuroradiology

- High-resolution neuroimaging with CT, MRI and PET scanning used to diagnose the full range of brain, spine and head/neck diseases.
- Advanced MRI and PET techniques that are leveraged to guide treatment and monitor treatment response.
- Ten neuroradiologists with Certificates of Additional Qualification (CAQs) who collaborate to ensure the highest level of imaging performance and interpretation.

## Neuropathology

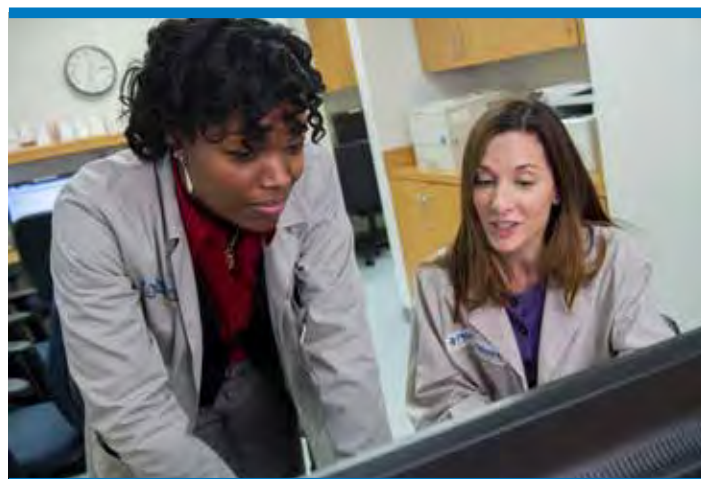
- Diagnostic services for neurosurgical specimens, autopsy brain and tumors, including molecular and genetic testing to determine customized care.

## Neuropsychology

- Consultation and evaluation services to a broad range of inpatients and outpatients with a variety of adult and pediatric neurological disorders.
- Cognitive rehabilitation and psychological care based on a patient-specific treatment plan that is coordinated with and provided by speech therapists, occupational therapists, learning disability specialists and clinical psychologists.

## Neurophysiology

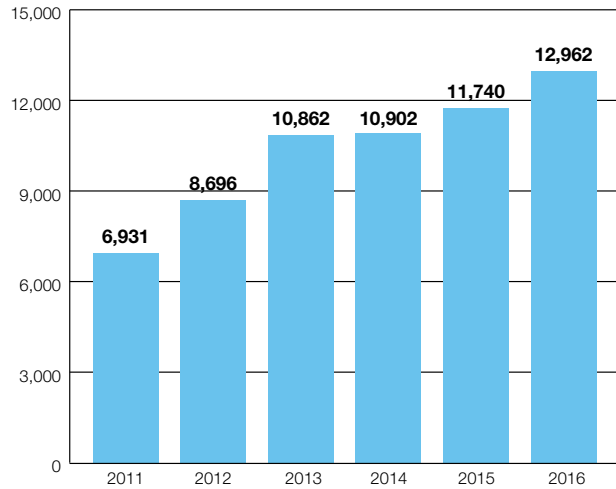
- High-quality diagnostic testing available including electroencephalography (EEG), nerve conduction studies, electromyography, evoked potentials (somatosensory, visual, acoustic brain stem), home and continuous inpatient EEG monitoring, intracranial monitoring, Wada test, functional brain mapping, DBS testing and video EEG in the EMU.
- Intraoperative monitoring where our team of physicians and technologists work with surgeons, monitoring the central and peripheral nervous system in order to avoid preventable complications.



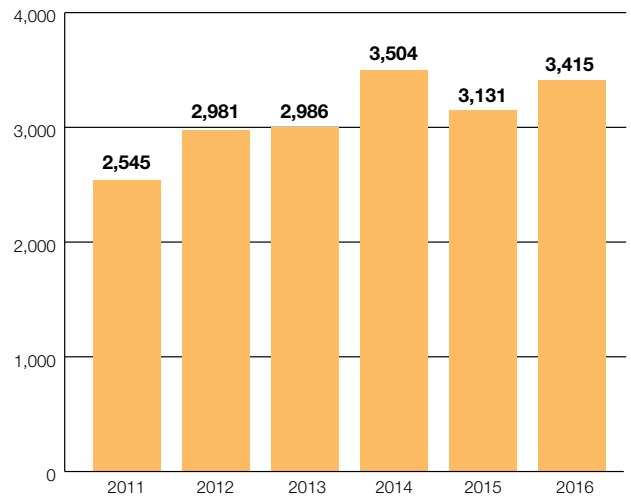
*Dr. Takijah Heard (left) Head of the Division of Pediatric Neurology, and Dr. Margaret Michelson (right) offer subspecialty neurological care to pediatric patients with epilepsy, neurophysiology and developmental disabilities.*

# Volume and Quality Data

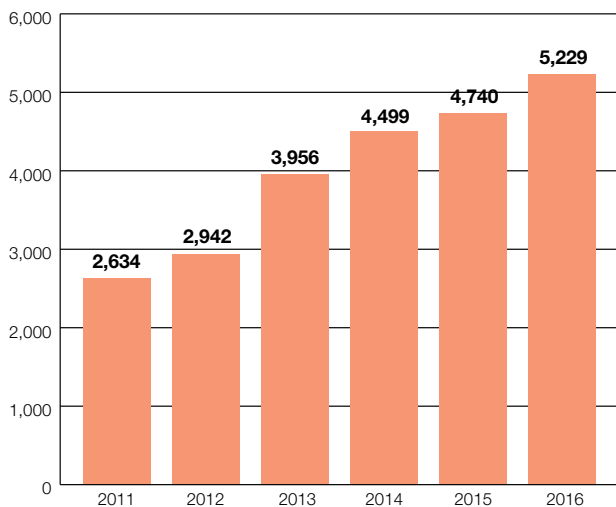
## Neurology New Patient Volumes



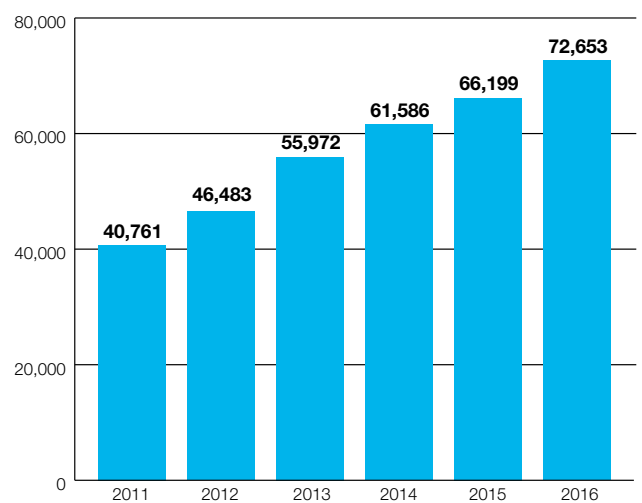
## Neurosurgery New Patient Volumes



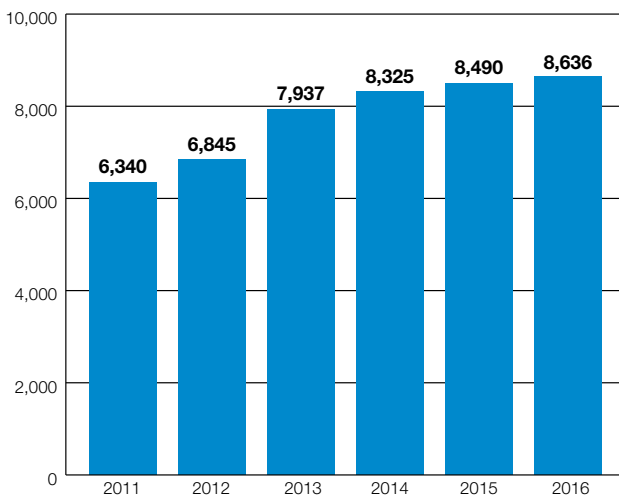
## Physical Medicine and Rehabilitation New Patient Volumes



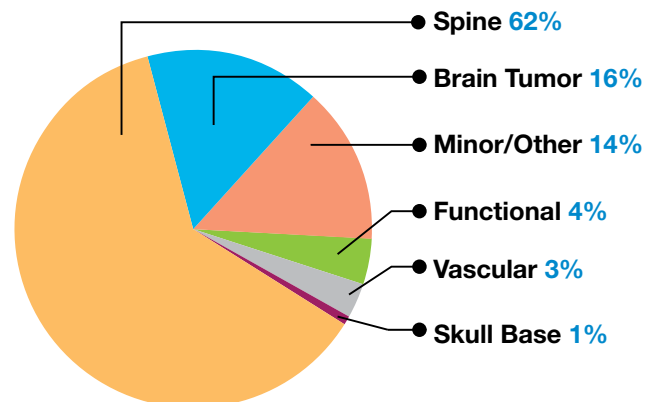
## NorthShore Neurological Institute Total Patient Volume (New and Established)



## Neurodiagnostic Procedures (Includes EEG, EMG, Evoked Potential, Intraoperative Monitoring, Autonomic Testing)



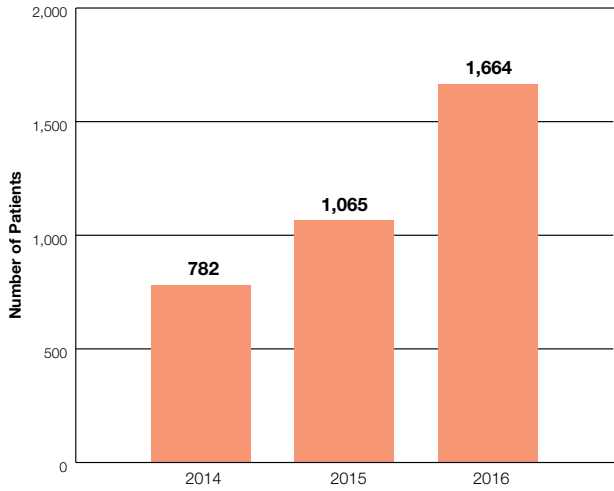
## Neurosurgical Cases by Type (FY2016)



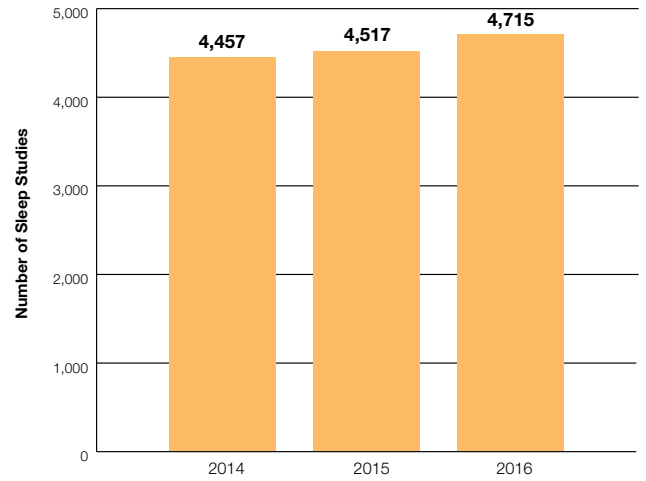
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# Volume and Quality Data

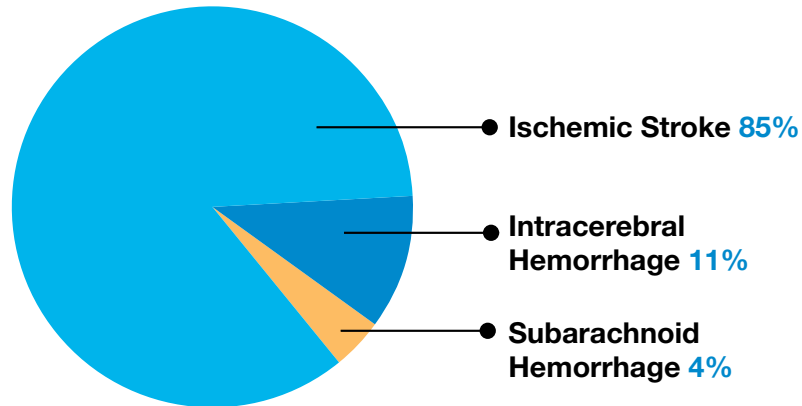
## Clinical Trial Enrollment



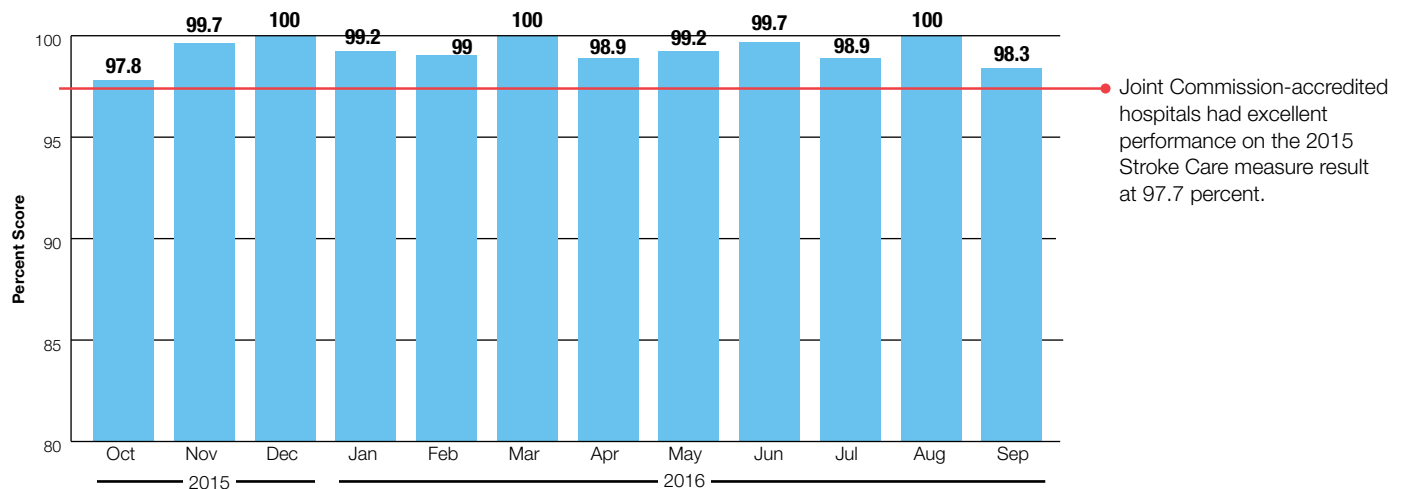
## Sleep Studies



## Stroke Cases by Type (FY2016)



## Composite Stroke Care Inpatient Quality Measure





The Department of Neurosurgery is a participant in the Quality and Outcomes Database (QOD) initiative. This project allows us to track quality, efficiency and ultimately the value of care for the most common neurosurgical procedures. The initiative was set up by the NeuroPoint Alliance—the data-collection arm of the American Association of Neurological Surgeons—with a broad coalition of other neurosurgical societies, including the Congress of Neurological Surgeons (CNS), Society of Neurological Surgeons (SNS) and American Board of Neurological Surgery (ABNS). The goal is to generate both quality and efficiency data to:

- Demonstrate comparative effectiveness of neurosurgical procedures;
- Determine which patients are most likely to benefit from specific surgical interventions; and
- Facilitate multicenter trials and other cooperative clinical studies.

NorthShore Neurological Institute was one of the very early sites that has contributed data to the QOD. The three-month and 12-month quality outcomes reports of some common neurosurgical procedures are shown.

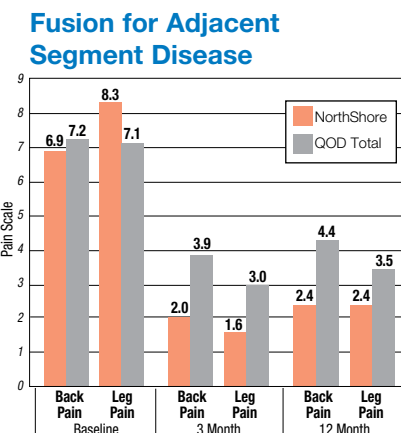
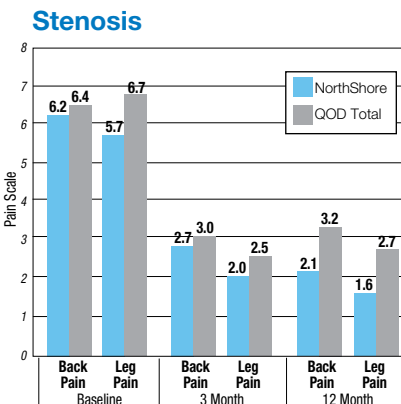
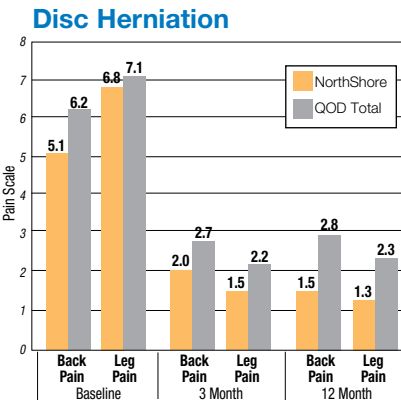
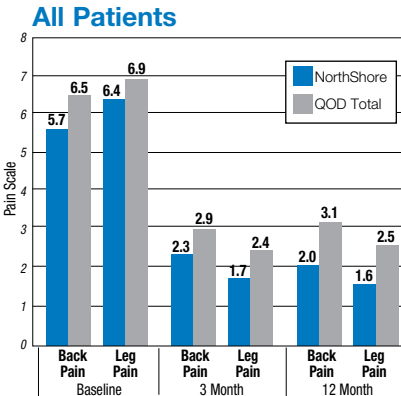
### Pain Scale

- 0 No pain  
 1–3 Mild pain: nagging, annoying, interfering little with activities of daily living  
 4–6 Moderate pain: interferes significantly with activities of daily living  
 7–10 Severe pain: disabling, unable to perform activities of daily living

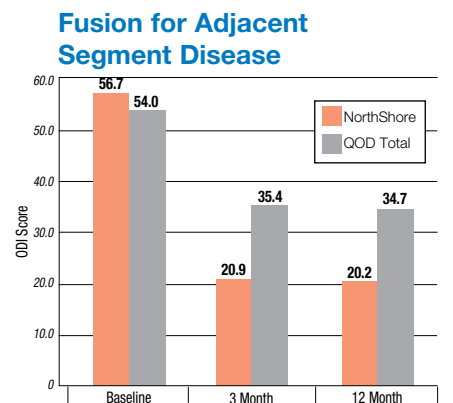
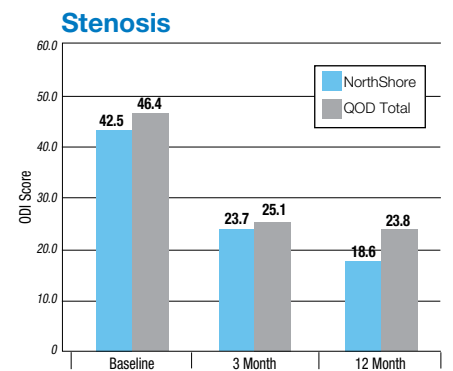
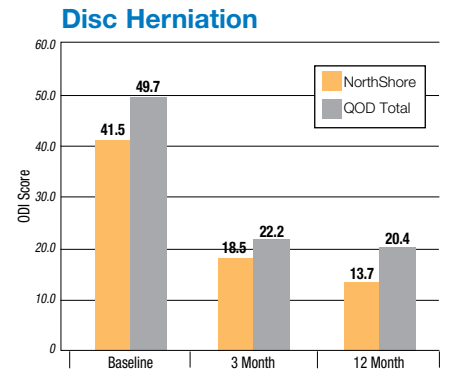
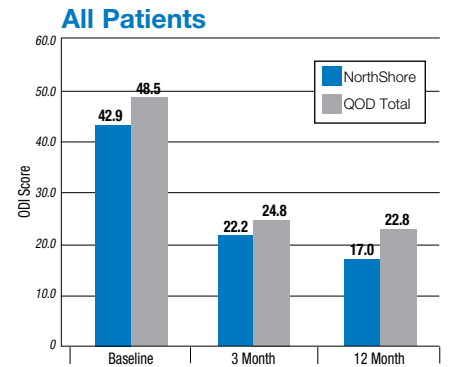
**The Oswestry Disability Index (ODI)** is an index derived from the Oswestry Low Back Pain Questionnaire used by clinicians and researchers to quantify disability for low back pain.

- 0–20 Minimal disability  
 21–40 Moderate disability  
 41–60 Severe disability  
 61–80 Crippling back pain  
 81–100 These patients either are bed-bound or have an exaggeration of their symptoms

## Pain Scale



## Oswestry Disability Index (ODI)



## Primary Prevention of Alzheimer's and Other Neurodegenerative Disorders

**The Center for Brain Health at NorthShore Neurological Institute aspires to preserve and improve brain health by preventing dementia, Alzheimer's disease, Parkinson's disease and other aging brain disorders. Experts use results of genetic testing, assessments of modifiable lifestyle factors and advanced diagnostics to equip patients with personalized prevention strategies to maintain brain health and avoid Alzheimer's disease and related neurodegenerative disorders.**

In the fight against Alzheimer's, the sooner in adulthood you start a brain health plan of action, the better your chances to prevent the disease. The same may hold true for Parkinson's disease and chronic traumatic encephalopathy (CTE).

Alzheimer's disease causes problems with memory, thinking and behavior; disrupts daily living; and robs people of their independence. One in five women and one in 10 men will develop symptoms of Alzheimer's in their lifetime.

Parkinson's disease impacts one million Americans and results in tremors, stiff muscles, slow movement and difficulties with walking or balance.

CTE is a progressive, degenerative brain disorder that is increasingly recognized in professional athletes and military personnel.

The Center for Brain Health is led by Demetrius M. Maraganore, MD. At the Center, patients may elect to receive genetic testing and advanced diagnostics while specialists focus on lifestyle and medical factors to predict and protect against Alzheimer's disease and related disorders.

Alzheimer's disease and aging brain disorders are progressive, often fatal neurodegenerative diseases. Longer life expectancy and unhealthy lifestyles and behaviors have combined to result in an expected epidemic. Risks for these diseases include genetic, medical and lifestyle factors. Our experts identified the factors listed below as having strong evidence in the literature as increasing or decreasing risk for Alzheimer's disease and related disorders.

### Factors that Increase Risk

- Genetic (APOE ε4, other susceptibility genes)
- Metabolic (cholesterol, diabetes, obesity)
- Vascular (cardiovascular disease, hypertension, stroke)
- Infectious/inflammatory (chronic periodontitis, others)
- Head trauma (multiple concussions)
- Diet (homocysteine, Standard American Diet, deficiencies)
- Lifestyle (smoking, alcohol abuse)
- Sleep (poor quality, disorders)
- Depression
- Early menopause (natural or surgical)
- Sedentary lifestyle
- Certain medications

### Factors that Decrease Risk

- Genetic (APOE ε2)
- Social (education, income, engagement)
- Lifestyle (physical and mental exercise, high work complexity)
- Diet (Mediterranean, polyunsaturated and fats from fish)
- Vitamins (B6, B12, Folate, A, C, D, E)
- Medications (nonsteroidal anti-inflammatory drugs, statins, early hormone replacement therapy, antihypertensives)

## ■ Personalized Brain Health Care

By proactively participating with our team of brain health experts, at-risk individuals get the support needed to successfully delay—and possibly prevent—brain disorders.

NorthShore’s team of specialists at the Center includes: neurologists, neuropsychologists, neuroradiologists, genetic counselors, physical therapists, dietitians, health psychologists, social workers, lifestyle coaches and researchers.

We implement personalized, evidence-based interventions to mitigate risk factors and maximize protective factors, as well as evidence-based interventions with the potential to benefit all patients. These interventions include lifestyle and behavioral changes, medications, and management of diseases associated with increased risk of Alzheimer’s disease. We maintain compliance-focused follow-up via interval visits with a physician assistant. Annual follow-up visits with the neurologist focus on updating risk profiles and modifying interventions according to outcomes and the latest evidence. If patients develop aging brain disorders despite our best efforts, they are transitioned at the earliest point to relevant neurology subspecialty practices.

Diagnostics include blood, genetic and imaging tests. Consults with a dietitian and physical therapy are also initiated when indicated.

To identify at-risk individuals, we have developed informatics tools built into the Electronic Medical Record (EMR) system: a web- and paper-based Brain Health Quiz, an EMR-based Alzheimer’s Risk Score Algorithm, and EMR-based flags.

The Brain Health Quiz is an unscored self-screening tool of evidence-based risk factors for Alzheimer’s disease, Parkinson’s disease and CTE by which individuals can learn about their risk factors and self-refer. We built into the EMR Best Practice Advisories that prompt neurologists to enroll patients into a DNA biobank (each patient is genotyped for one million single nucleotide polymorphism markers), which will enable genomic discoveries related to brain health.

**“Our purpose is to primarily prevent Alzheimer’s disease and related disorders through EMR-based screening, risk assessments, interventions and surveillance with the aim to shift the paradigm in neurology from brain disease to brain health.”**

— Dr. Demetrius Maraganore





# Clinical Highlights

## Amyotrophic Lateral Sclerosis (ALS) Clinic and Autonomic Laboratory

**NorthShore Neurological Institute has opened the first clinic devoted to ALS in the northern suburbs and is working with the ALS Association Greater Chicago Chapter to develop an accredited ALS treatment center.**

ALS, also known as Lou Gehrig's Disease, is a progressive disease that affects nerve cells in the brain and spinal cord. Speech, swallowing and movement gradually deteriorate in ALS patients.

NorthShore's ALS Clinic led by Octavia Kinkaid, MD, specializes in the management, care and support of people with ALS, providing resources and clinical expertise that make it easier for patients to cope effectively with ALS and optimize the quality of daily life.

A collaborative multidisciplinary team including neurologists; occupational, physical and speech therapists; social workers; and nutritionists works together to provide answers and solutions to patients and their families. This approach ensures that team members work closely together and consult with one another regularly to help ensure the highest level of care possible.

Sponsored by the ALS Association Greater Chicago Chapter, our full-service clinic offers a personalized coordinated care experience all in one convenient location. A dedicated neurology nurse specialist and a home care representative from the ALS Association are also available.

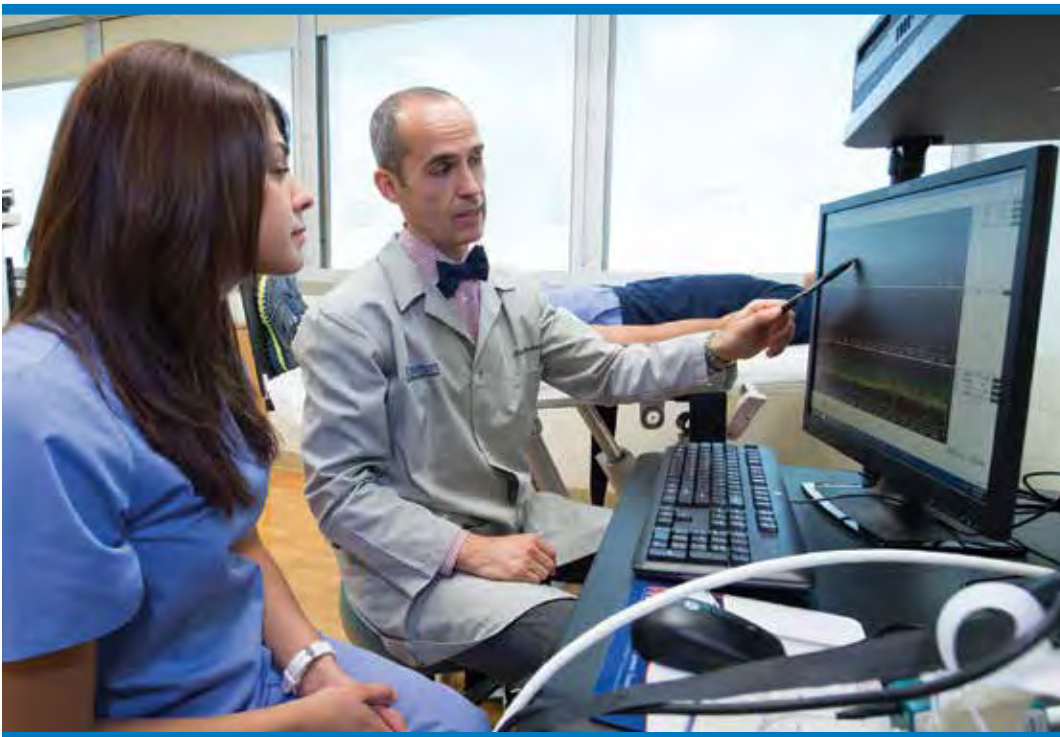
**"My goal is to maintain a patient's independence, comfort and quality of life for as long as I can."**

— Dr. Octavia Kinkaid



### ■ Autonomic Lab Tests

The Neuromuscular Program includes a state-of-the-art Autonomic Testing Lab. Led by fellowship-trained physician and director of the Neuromuscular Program, Alexandru Barboi, MD, the Autonomic Testing Lab assists Dr. Barboi in making a comprehensive diagnosis of autonomic system disorders.



**Dr. Alexandru Barboi (right) reviews a patient's diagnostic tests with a technician in our state-of-the-art autonomic laboratory.**

## Responsive Neurostimulation (RNS) to Treat Epilepsy

**NorthShore Neurological Institute has begun offering the revolutionary NeuroPace RNS® System implant to prevent seizures at the source by monitoring and responding to brain activity.**

Epilepsy is a major public health problem that affects 1 to 4 percent of the general population. Most efforts are targeted to the development of increasing numbers of antiepileptic drugs—more than 20 such drugs are used clinically today. However, despite this availability, 30 to 40 percent of patients do not respond to them and continue to have “uncontrolled” or “refractory” seizures—a condition termed “intractable epilepsy.”

NorthShore Neurological Institute is one of the few places in the country to now offer a revolutionary technology for treating adults with intractable epilepsy—the surgically implanted NeuroPace RNS System.

For certain patients with seizures that arise from more than one brain region and/or from brain regions that cannot be removed surgically, using an implanted neurostimulator to treat seizures can be more effective than medications alone. Since no brain tissue is removed, it can involve less risk than other surgical options.

**A small, battery-powered neurostimulator is surgically implanted in the skull. Leads that are connected to the neurostimulator are placed on the surface and/or inside the brain. The neurostimulator monitors the electrical activity of the brain 24/7. When abnormal activity is detected, the neurostimulator responds with small electrical stimulation to the brain through the leads to prevent seizures.**

**“Our care team includes neurologists and neurosurgeons with expertise in the diagnosis and management of epilepsy. We evaluate patients for eligibility to receive RNS as a state-of-the-art treatment.”**

— Dr. Jaishree Narayanan (left)

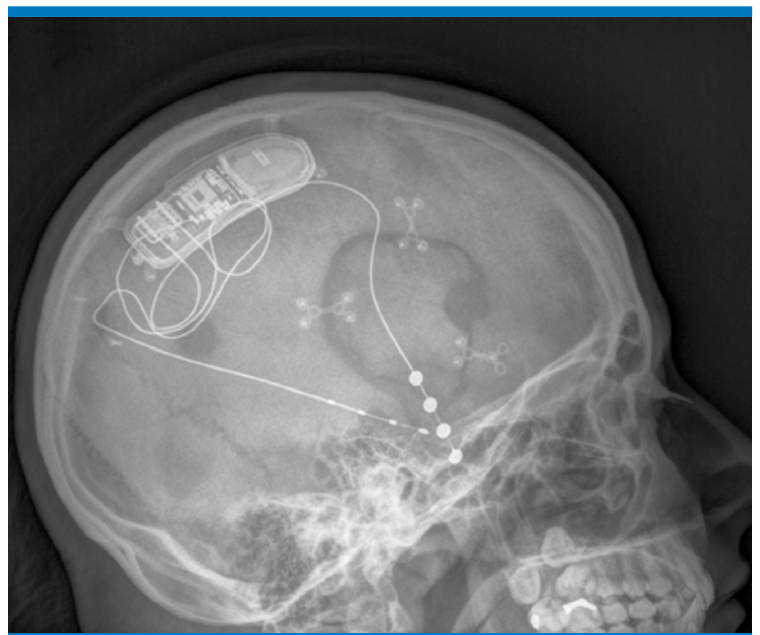
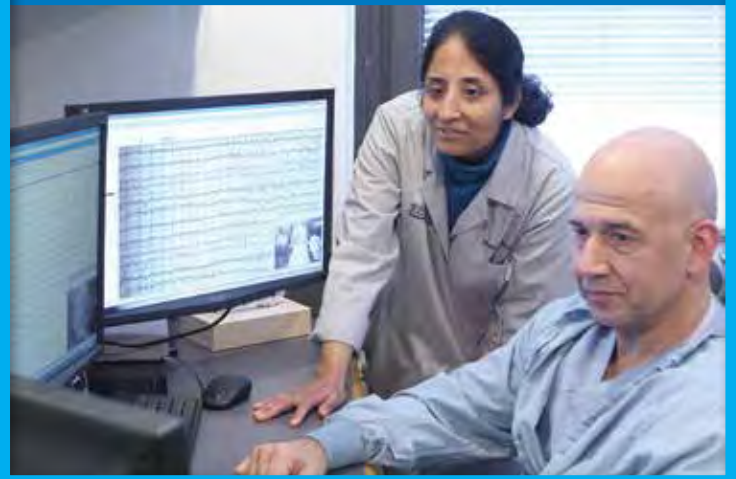


Image from Thomas et al. Med Devices (Auckl) 2015.

# Clinical Highlights

## Advances in Subcortical Surgery for Hemorrhagic Stroke and Brain Tumors

**NorthShore Neurological Institute is the only site in Chicago that is using a combination of two advanced tools—the BrightMatter™ Servo Solution and NICO BrainPath—which delivers optimized imaging and minimally invasive access to the subcortical space for surgical removal of deep brain hemorrhagic blood clots and lesions.**

BrightMatter uses a tractography imaging method called diffusion tensor imaging (DTI) to enhance images of the entire brain's pathways, allowing surgeons to see structures that cannot be seen with the naked eye. This information is then used to consider the optimal navigation approaches to allow access to brain locations previously deemed inoperable. The navigation is combined with a high-powered magnification system mounted onto a robotic arm to view the anatomy in unprecedented detail.

The BrainPath is a tubular retractor that provides surgical site access to lesions in the subcortical regions of the brain. Using real-time information from tractography and minimally invasive techniques, the neurosurgeon moves the retractor through the natural folds of the cortex and delicate fibers of the brain. Once the BrainPath is at the correct position, the opening to the retractor is removed and a sheath remains to serve as a protective portal for surgeons to easily maintain access to the surgical site to remove the blood clot from hemorrhagic stroke or a brain lesion.



**“These advanced tools available at NorthShore Neurological Institute combine real-time imaging, navigation, advanced optics and robotic positioning to help reduce operative time and improve outcomes.”**

— Dr. Julian Bailes (right)

**Panel shows images of the insertion of BrainPath for subcortical surgery to remove a blood clot. Using a dime-sized opening (A), the selected sulcus is opened widely before advancing the retractor (B). Once the retractor is advanced to the desired length, the opening is removed and the retractor fixed. High-powered magnification is used to visualize the subcortical hematoma (C). The final image (D) shows the entry site after decannulation and with preservation of the cortical vein.**

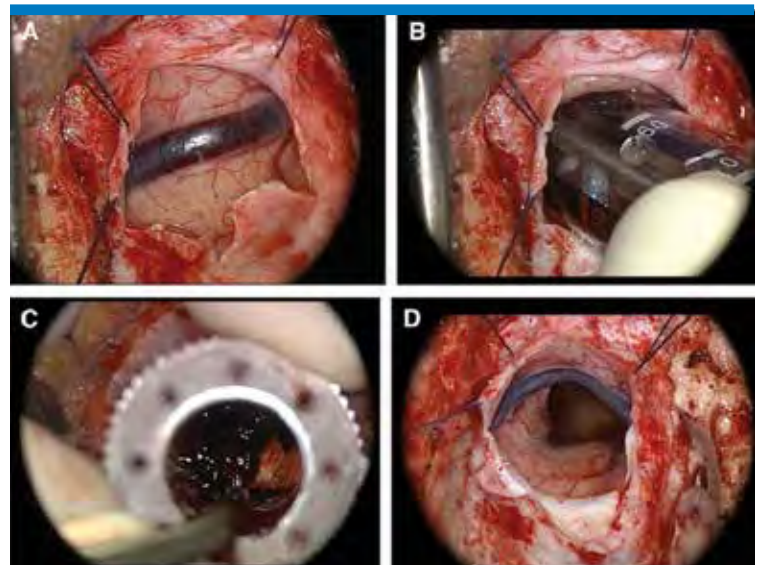


Image from Labib et al Neurosurgery 2016.



## Advances in Minimally Invasive and Motion-Preserving Spine Surgery

NorthShore Neurological Institute is a leader in offering the latest minimally invasive spine surgical options. These includes the **coflex® Interlaminar Stabilization device** and **STALIF C® Integrated Interbody device**.

The coflex Interlaminar Stabilization device is for people with moderate to severe lumbar stenosis in one or two vertebral segments. Michael Musacchio, MD, neurosurgeon at NorthShore Neurological Institute, was involved in a longitudinal study that compared the device when used in combination with decompression against standard fusion with decompression. The results of this study showed coflex to be a durable and lasting procedure for patients with lumbar stenosis, with low risk of complications and the need for reoperation. There also were fewer major complications that were device-related in the coflex group compared to fusion.

The STALIF C is an advanced technology that is a single device that replaces the disc portion of the damaged spinal segment. STALIF C is secured with three specially designed screws. The procedure encourages fusion between the vertebrae above and below the affected spinal segment. This type of surgery generally requires less operative time and is less invasive leading to shorter recovery time, allowing the patient to return to daily activity more quickly.

Panel shows images of the microsurgical decompression at L3-L4 with the coflex Interlaminar Stabilization device. Top right is the device in flexion, and bottom right is the device in extension.

**“The primary benefits of these advances are that they’re less invasive with shorter recovery times, less risk, and quicker return to normal activities.”**

— Dr. Michael Musacchio



Image courtesy of Paradigm Spine.

## 3-D Surgical Planning and Patient Engagement

**NorthShore Neurological Institute is in a select group of sites nationwide— and the only site in Chicagoland— that is pioneering the use of virtual reality in neurosurgery using Surgical Theater for patient engagement and surgical planning.**

Surgical Rehearsal Platform (SRP) from Surgical Theater provides a patient-specific virtual surgery theater that allows neurosurgeons to plan, rehearse and perform surgery with interactive tools in a 3-D environment. The system consists of the SRP software program capable of generating 3-D stereoscopic output, 3-D controllers and 3-D stereoscopic vision glasses.

Medical images such as CT or MRI scans of a patient's studies are uploaded to the SRP and transformed into a dynamic model that can be manipulated and viewed at any angle. The processing time from the scanned image to a ready-to-use rehearse model is approximately 20 minutes. Stereoscopic visuals give the surgeon a realistic 3-D experience. Because the anatomy of the pathology is derived from patient-specific images, the SRP allows interactions between the surgeon's

instruments in 3-D and lets neurosurgeons rehearse techniques specific to a patient's neurosurgical procedure.

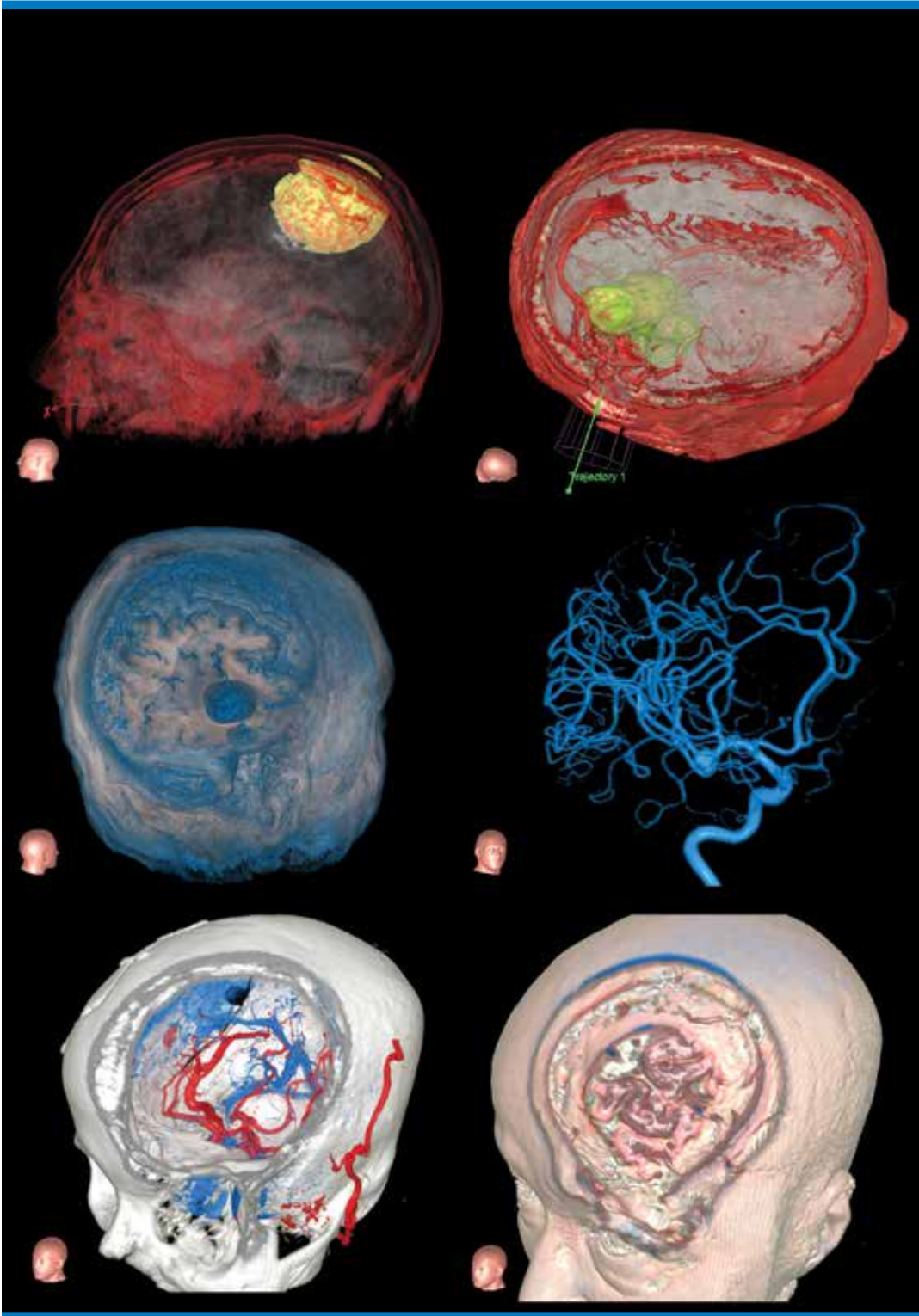
Apart from surgical planning, SRP is used to personalize the preoperative patient education session about their upcoming neurosurgical procedure. The session involves a multimedia presentation using patient-specific virtual reality simulation provided by SRP. The neurosurgical education experience helps patients and their families become more informed about their minimally invasive surgeries, adopt more realistic expectations about outcomes, and undergo less anxiety and apprehension about the course of postsurgical recovery.

Using the SRP technology in this way vastly improves upon the conventional method using black and white 2-D images from an MRI or CT scan. Some of the types of presurgical images produced by the software are shown on the facing page.

**“As an early adaptor of virtual reality in neurosurgery, I have already conducted multiple neurosurgical procedures utilizing Surgical Theater and have also used the software for presurgical patient orientation sessions.”**

— Dr. Shakeel Chowdhry





Examples of various applications of the patient-specific 3-D surgical planner.

(Top left) View of a parietal lobe meningioma shows ability to extract tumors from the MRI and highlight them separately.

(Top right) Glioblastoma with a virtual trajectory/corridor allowing the surgeon to plan the best approach to minimize damage.

(Middle left) View of a brain tumor in the back of the head, highlighting the technology's ability to cut away to view any angle and highlight different levels of anatomy.

(Middle right) 3-D rendering of an aneurysm with just the vessels shown based off an angiogram, highlighting the technology's ability to isolate certain structures in the brain.

(Bottom left) Rendering built from an overlay of high-quality magnetic resonance angiogram, magnetic resonance venography, CT and MRI.

(Bottom right) Same image but with addition of rendering to reveal brain tissue.



## Minimally Invasive Skull Base Surgery Techniques

**NorthShore Skull Base and Pituitary Surgery Program experts are at the forefront of innovative minimally invasive approaches to treat pituitary tumors, acoustic neuroma and trigeminal neuralgia.**

NorthShore's Skull Base Surgery team of Ricky Wong, MD; Joseph Raviv, MD; and Michael Shinnars, MD, are using endoscopic endonasal approaches through the nose and keyhole approaches behind the eyebrow or at the hairline to gain access to the brain, skull base and upper spine.

The introduction of specially designed keyhole instruments and adept use of both the microscope and endoscope have now allowed the area of safe surgical maneuverability to become smaller so that two-centimeter craniotomy is sufficient. According to Dr. Wong, "These approaches translate into improved outcomes with shorter exposure time, lower infection rates, less muscle atrophy, improved restoration, less postoperative pain and shorter length of stay."

Dr. Wong, Dr. Raviv and Dr. Shinnars have also helped the next generation of neurosurgeons in these techniques by leading instruction for an annual two-day event teaching microsurgical and minimally invasive skull base surgery techniques (see below).



**"To perform these minimally invasive techniques requires detailed anatomic knowledge, careful selection, planning and placement of the opening."**

– Dr. Ricky Wong

**Participants pictured learning the latest endoscopic techniques at the *Chicago Skull Base Surgery Hands-On Course*. Instruction was led by NorthShore's Skull Base Surgery team and held in the Neurosurgery Skull Base Laboratory housed in the Grainger Center for Simulation and Innovation.**

**The conference sessions included dynamic, intensive hands-on cadaveric dissection sessions, which provided participants the opportunity to perform various microsurgical and endoscopic skull base procedures.**



# Research

NorthShore Neurological Institute is committed to conducting medical research with the goal of helping patients live longer, healthier lives. Studies involve patient and community volunteers with the goal of better understanding how to diagnose, treat and prevent neurological diseases and conditions. For an up-to-date list of clinical trials currently enrolling patients at NorthShore Neurological Institute, go to: [northshore.org/neurological-institute/research-innovation](http://northshore.org/neurological-institute/research-innovation).



A multidisciplinary research staff of neurologists, neurosurgeons, neuroradiologists, neuropsychologists, neuropathologists and a large team of research personnel are engaged in a wide array of clinical studies, often national and international in scope.

## NorthShore Neurological Institute Research— By the Numbers 2016

### ■ Research Personnel

<b>Total Research Personnel</b>	<b>21</b>
• Administrative Director (MD)	1
• Research Scientist (PhD)	1
• Medical and Scientific Writer (PhD)	1
• Research Manager	1
• Dietitian (MS)	1
• Senior Clinical Research Associate (MPH)	1
• Clinical Research Associate	1
• Research Nurses	2
• Research Coordinators	4
• Research Assistants	7
• Seasonal Employee	1

### ■ Investigators

<b>Total Investigators</b>	<b>23</b>
• Principal Investigators	15
• Other Investigators	8

### ■ Publications

<b>Peer-Reviewed Articles</b>	<b>44</b>
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### ■ Research Studies

<b>Total Open Studies</b>	<b>53</b>
• Animal Studies (Traumatic Brain Injury)	4
• Human Subject Studies	49
– Alzheimer's Disease	1
– DodoNA: (Parkinson's, Migraine, Multiple Sclerosis, Restless Legs Syndrome, Mild Traumatic Brain Injury, Epilepsy, Brain Tumors, Memory, Brain Health, Stroke, Neuromuscular <i>(in order of implementation)</i> )	1
– Brain Aneurysm	1
– Chronic Traumatic Encephalopathy	1
– Humanitarian Use Devices: (2 Brain Aneurysms; 1 Stroke)	3
– Multiple Sclerosis	6
– Neuro-Oncology	17
– Neuromuscular	3
– Neurophysiology	1
– Neurology Practice-Based Research Network	1
– Parkinson's Disease	6
– Stroke	5
– Spine	3
<b>Total Subjects Consented</b>	<b>1,664</b>

## **The DodoNA Project** (see pages 25, 26 and 27)

### **The DodoNA Project: DNA Predictions to Improve Neurological Health**

Aims: “DodoNA” is a metaphor. Dodona was an oracle of ancient Greece, where priestesses interpreted the rustling leaves of a sacred oak tree to predict the future and to guide actions to improve fate. Just as at Dodona, we can interpret subtle variations in DNA, the “tree of life,” to improve neurological health. Specifically, we are developing medical informatics tools to capture standardized data via routine office visits that measure the progression and outcomes of patients with the following neurological disorders: brain tumors, epilepsy, memory disorders, migraine, mild traumatic brain injury, multiple sclerosis, neuropathy, Parkinson’s disease, restless legs syndrome and stroke. We are also studying persons who are neurologically healthy but at increased risk for Alzheimer’s disease and related brain disorders.

DodoNA is a clinical practice initiative (note-writing and workflow efficiencies) and a quality initiative (best practices). It is also a research initiative. We will invite up to 1,000 subjects for each of the 11 projects (11,000 subjects in total) to provide, via informed consent, a blood sample for DNA extraction and storage. We then will ask permission to associate information in their blood with information in their medical record (for the purposes of developing molecular prognostics and therapeutics).

Principal Investigator: Demetrius Maraganore, MD  
NorthShore Project Number: EH10-139  
Contact: Call (847) 503-4344 with questions regarding the study.

## **Practice-Based Research**

### **Quality Improvement and Practice-Based Research in Neurology Using the EMR**

Aims: The purpose of this study is to advance quality improvement and practice-based research in neurology using the Electronic Medical Record (EMR) system. The Department of Neurology at NorthShore has built into its commercial EMR (called “Epic”) structured clinical documentation support (SCDS) and clinical decision support (CDS) tools that standardize care, write progress notes, and capture ~1,000 discrete and cascading fields of neurological data per office visit. The specific aims of this project are to first create a Neurology Practice-Based Research Network (NPBRN) by sharing SCDS and CDS tools for 10 common neurological disorders (brain tumors, epilepsy, migraine, mild cognitive impairment, mild traumatic brain injury, multiple sclerosis, neuropathy, Parkinson’s disease, restless legs syndrome and stroke) and for brain health (11 projects total) with seven other Neurology Departments nationwide that also use the Epic EMR platform (eight sites total). Secondly, we will individualize medicine at the point of care by conducting pragmatic trials using subgroup-based adaptive designs, comparing the effectiveness of available treatments for common neurological disorders.

Principal Investigator: Demetrius Maraganore, MD  
NorthShore Project Number: EH14-355  
Contact: Call (847) 570-1631 with questions regarding the study.

## **Brain Aneurysm Clinical Trials**

### **Humanitarian Use Device: Neuroform Microdelivery Stent System**

Aims: The Neuroform Microdelivery Stent System is used with coils for treating wide-neck aneurysms in the brain that cannot be treated with open brain surgery.

Principal Investigator: Shakeel Chowdhry, MD  
NorthShore Project Number: EH12-352  
Contact: Call (847) 570-4224 with questions regarding the device.

### **Humanitarian Use Device: CODMAN ENTERPRISE Vascular Reconstructive Device and Delivery System**

Aims: This device is used for treatment of wide-neck aneurysms. A stent is placed across the opening or neck of the aneurysm to secure the placement of coils and to maintain blood flow through the artery in which the stent is placed.

Principal Investigator: Shakeel Chowdhry, MD  
NorthShore Project Number: EH12-354  
Contact: Call (847) 570-4224 with questions regarding the device.

### **Humanitarian Use Device: Wingspan Stent System with Gateway PTA Balloon Catheter**

Aims: This device is used to increase cerebral artery blood flow in patients with intracranial atherosclerotic disease. A stent is placed in the affected area and is deployed by inflation of a very small balloon, which widens the occluded vessel.

Principal Investigator: Shakeel Chowdhry, MD  
NorthShore Project Number: EH12-355  
Contact: Call (847) 570-4224 with questions regarding the device.

### **Humanitarian Use Device: LVIS™ Intraluminal Support Device and LVIS™ Jr. Intraluminal Support Device**

Aims: The LVIS and LVIS Jr. devices are intended for use with bare platinum embolic coils (used in aneurysm coiling) for the treatment of unruptured, wide-neck, intracranial, saccular aneurysms arising from a parent vessel. The purposes of the devices are to provide support, secure placement of the coils and maintain blood flow through the artery in which the device is placed.

Principal Investigator: Shakeel Chowdhry, MD  
NorthShore Project Number: EH12-355  
Contact: Call (847) 570-4224 with questions regarding the device.

### **SMART—A prospective, multicenter registry assessing the embolization of neurovascular lesions using the Penumbra SMART COIL® System**

Aims: The purpose of this study is to gather real-world, postmarket data on the Penumbra SMART COIL (Smart System) in the treatment of intracranial aneurysms and other neurovascular abnormalities and malformations.

Principal Investigator: Shakeel Chowdhry, MD  
NorthShore Project Number: EH17-111  
Contact: Call (847) 570-4224 with questions regarding the study.



## Brain and Spine Tumor Clinical Trials

### Expanded Access (Compassionate Use) Treatment Protocol Rindopepimut (CDX-110)

Aims: This protocol has been developed to offer expanded access to rindopepimut to patients who do not qualify for enrollment into an open trial of rindopepimut or where the closest open clinical trial site is geographically inaccessible.

Principal Investigator: Ryan Merrell, MD  
NorthShore Project Number: EH12-370

Contact: Call (847) 570-2025 with questions regarding the study.

### A Phase III Randomized, Double-Blind, Placebo-Controlled Study of Armodafinil (Nuvigil) to Reduce Cancer-Related Fatigue in Patients with High-Grade Glioma

Aims: The purpose of this study is to determine whether taking the drug armodafinil will improve problems with fatigue in patients with glioma and to evaluate the effects of taking armodafinil as compared to a placebo on cancer-related fatigue and on cognitive function.

Principal Investigator: Ryan Merrell, MD  
NorthShore Project Number: EH13-248

Contact: Call (847) 570-2025 with questions regarding the study.

### A Phase II Randomized Trial Comparing the Efficacy of Heat Shock Protein-Peptide Complex-96 (HSPPC-96) (NSC #725085, Alliance IND #15380) Vaccine Given with Bevacizumab versus Bevacizumab Alone in the Treatment of Surgically Resectable Recurrent Glioblastoma Multiforme (GBM)

Aims: The purpose of this study is to evaluate whether the addition of HSPPC-96 to bevacizumab can improve the overall survival in patients with resectable recurrent glioblastoma.

Principal Investigator: Ryan Merrell, MD  
NorthShore Project Number: EH13-264

Contact: Call (847) 570-2025 with questions regarding the study.

### EAY131 Molecular Analysis for Therapy Choice (MATCH)

Aims: The study is designed to assign targeted treatment based on a biopsy obtained just before study entry.

Principal Investigator: Robert Marsh, MD  
NorthShore Project Number: EH15-387

Contact: Call (847) 570-2025 with questions regarding the study.



Dr. Ryan Merrell is Director of the Neuro-Oncology Program and principal investigator of several innovative brain tumor clinical trials.

### YELLOW 560 Microscope for Intraoperative Visualization of Fluorescein-Stained High-Grade Gliomas

Aims: The purpose of this study is to assess the use of a yellow, fluorescent dye in combination with a specialized microscope during brain surgery for the removal of a specific type of tumor called a high-grade glioma. Objectives include measuring patient outcomes and measuring the extent of tumor removal.

Principal Investigator: Julian Bailes, MD  
NorthShore Project Number: EH13-331

Contact: Call (847) 570-4224 with questions regarding the study.

### A Phase III Randomized Double-Blind, Controlled Study of ICT-107 with Maintenance Temozolomide (TMZ) in Newly Diagnosed Glioblastoma Following Resection and Concomitant TMZ Chemoradiotherapy

Aims: The primary objective is to determine the overall survival of subjects treated with ICT-107 and SOC (RT and temozolomide) versus placebo control and SOC (RT and temozolomide).

Principal Investigator: Ryan Merrell, MD  
NorthShore Project Number: EH15-230

Contact: Call (847) 570-2025 with questions regarding the study.

### A Randomized, Placebo-Controlled Phase 2b/3 Study of ABT-414 with Concurrent Chemoradiation and Adjuvant Temozolomide in Subjects with Newly Diagnosed Glioblastoma Multiforme (GBM) with Epidermal Growth Factor Receptor (EGFR) Amplification (Intelligence 1)

Aims: The primary objective of Phase 2b is to determine whether the addition of ABT-414 to concomitant radiotherapy and temozolomide plus adjuvant temozolomide prolongs progression-free survival (PFS) among subjects with newly diagnosed GBM harboring *EGFR* amplification. The primary objective of Phase 3 is to determine whether the addition of ABT-414 to concomitant radiotherapy and temozolomide plus adjuvant temozolomide prolongs overall survival (OS) among subjects with newly diagnosed GBM harboring *EGFR* amplification.

Principal Investigator: Ryan Merrell, MD  
NorthShore Project Number: EH16-003

Contact: Call (847) 570-2025 with questions regarding the study.

### Compassionate Use of ABT-414 for the Treatment of Glioblastoma Multiforme

Aims: The purpose of this study is to provide the drug currently being studied in an ongoing research study to patients who do not meet criteria to participate in the main study.

Principal Investigator: Ryan Merrell, MD  
NorthShore Project Number: EH16-127

Contact: Call (847) 570-2025 with questions regarding the study.

## Dementia Clinical Trial

### Imaging Dementia—Evidence for Amyloid Scanning (IDEAS) Study: A Coverage with Evidence Development Longitudinal Cohort Study

Aims: The IDEAS Study is an observational, open-label, longitudinal cohort study designed to assess the impact of amyloid positron emission tomography (PET) on patient-oriented outcomes in Medicare beneficiaries with mild cognitive impairment (MCI) or dementia of uncertain etiology.

Principal Investigator: Chad Yucus, MD  
NorthShore Project Number: EH16-007

Contact: Call (847) 503-4322 with questions regarding the study.

(continued)

# Actively Enrolling Clinical Trials



*Dr. Afif Hentati is Director of the Multiple Sclerosis Program and principal investigator of clinical trials for the treatment of multiple sclerosis.*

## Multiple Sclerosis Clinical Trial

### **H.P. Acthar® Gel Prospective Registry: A Prospective Registry of H.P. Acthar Gel for the Treatment of Multiple Sclerosis (MS) Relapse**

Aims: This study aims to characterize the patient population and describe MS exacerbation recovery, treatment patterns and safety outcomes in patients who receive Acthar Gel to treat acute MS exacerbations.

Principal Investigator: Afif Hentati, MD  
NorthShore Project Number: EH15-398  
Contact: Call (847) 570-1439 with questions regarding the study.

## Neuromuscular Disorder Clinical Trials

### **Compassionate Use of 3,4-Diaminopyridine in Lambert-Eaton Myasthenic Syndrome**

Aims: The purpose of this study is to assess the use of 3,4-diaminopyridine in patients with Lambert-Eaton myasthenic syndrome.

Principal Investigator: David Randall, DO  
NorthShore Project Number: EH02-041  
Contact: Call (847) 657-5875 with questions regarding the study.

### **An Open-Label, Expanded Access Protocol for Firdapse® (Amifampridine Phosphate; 3,4-Diaminopyridine Phosphate) Treatment in Patients with Lambert-Eaton Myasthenic Syndrome (LEMS), Congenital Myasthenic Syndrome (CMS) and Downbeat Nystagmus**

Aims: The primary objective of this study is to provide patients with LEMS/CMS/downbeat nystagmus access to amifampridine phosphate therapy until the product becomes commercially available. The secondary objective of the study is to assess the long-term safety of amifampridine.

Principal Investigator: Alexandru Barboi, MD  
NorthShore Project Number: EH16-121  
Contact: Call (847) 570-4046 with questions regarding the study.

### **Patient-Assisted Intervention for Neuropathy: Comparison of Treatment in Real-Life Situations (PAIN-CONTRoLS)**

Aims: Some neuropathies are secondary to readily identifiable causes. For approximately 25 to 50 percent of neuropathies, though, the cause is unknown. These are referred to as cryptogenic sensory polyneuropathy (CSPN). The primary aims of this study are: (1) to determine which of four pharmaceutical therapies is most effective in producing pain relief and improving quality of life in patients with CSPN, and (2) to determine which drug causes the fewest side effects, and which drug causes the most side effects. The four drugs being evaluated are nortriptyline, duloxetine, pregabalin and mexiletine.

Principal Investigator: Alexandru Barboi, MD  
NorthShore Project Number: EH17-011  
Contact: Call (847) 503-4322 with questions regarding the study.

## Neuro-Ophthalmology Clinical Trial

### **A Phase 2/3, Randomized, Double-Masked, Sham-Controlled Trial of QPI-1007 Delivered by Single- or Multi-Dose Intravitreal Injection(s) to Subjects with Acute Nonarteritic Anterior Ischemic Optic Neuropathy (NAION)**

Aims: This study will test whether the experimental drug QPI-1007 helps prevent visual loss that can occur in NAION. The study will also collect information about whether the experimental drug is safe for humans when it is injected into the eye.

Principal Investigator: John Pula, MD  
NorthShore Project Number: EH16-164  
Contact: Call (847) 657-1750 with questions regarding the study.

## Parkinson's Disease and Movement Disorder Clinical Trials

### **The Longitudinal Clinical and Genetic Study of Parkinson's Disease (LONG-PD Study)**

Aims: The clinical and genetic factors that influence motor and non-motor severity, progression and outcomes in Parkinson's disease are unknown. Identification of these factors may allow us to individualize the care of patients and improve neurological health. The Genetic Epidemiology of Parkinson's Disease (GEOPD) consortium clinics care for thousands of patients each year. The purpose of this study is to develop a web-based platform for the capture and sharing of standardized data that measure motor and nonmotor severity, progression and outcomes in Parkinson's disease across 25 global sites—from 18 countries, 5 continents, 4,200 cases. These patients will be followed for 15 years for collaborative research studies. Additionally, DNA will be shared in a central repository to conduct genomic studies of severity, progression and outcomes in Parkinson's disease.

Principal Investigator: Aikaterini (Katerina) Markopoulou, MD, PhD  
NorthShore Project Number: EH15-283  
Contact: Call (847) 503-4319 with questions regarding the study.

### **An Open-Label, Phase 3 Study Examining the Long-Term Safety, Tolerability and Efficacy of APL-130277 in Levodopa Responsive Patients with Parkinson's Disease Complicated by Motor Fluctuations ("OFF" Episodes)**

Aims: The purpose of this study is to determine whether the study drug, APL-130277, is effective, safe and well-tolerated in patients with Parkinson's disease who have "OFF" episodes. APL-130277 is a fast-acting thin film formulation of apomorphine that is placed under the tongue (sublingual) and is intended to be an alternative to the injectable form of apomorphine.

Principal Investigator: Aikaterini (Katerina) Markopoulou, MD, PhD  
NorthShore Project Number: EH15-170  
Contact: Call (847) 503-4322 with questions regarding the study.



*Dr. Aikaterini (Katerina) Markopoulou is Director of the Parkinson's Disease and Movement Disorders program and principal investigator of the several clinical trials linking clinical and genetic data with outcomes.*

### **Genetic Analysis of Familial Parkinsonism**

**Aim:** The purpose of this study is to identify inherited factors that may cause Parkinson's disease or Parkinsonism.

**Principal Investigator:** Aikaterini (Katerina) Markopoulou, MD, PhD  
**NorthShore Project Number:** EH16-166  
**Contact:** Call (847) 503-4322 with questions regarding the study.

### **Spine Surgery Clinical Trials**

#### **A Prospective Clinical Evaluation of the Centinel Spine™ STALIF C® No Profile® Integrated Interbody™ Fusion Device**

**Aims:** This is a postmarket analysis study of FDA-approved cervical fusion devices: The STALIF C and STALIF C-Ti™. The purpose of this study is to collect information about how well different types of patients do after spinal fusion, based on their earlier treatments (conservative therapy). This study is designed to better understand the links between conservative care, spinal fusion and patient outcomes.

**Principal Investigator:** Michael Musacchio, MD  
**NorthShore Project Number:** EH15-059  
**Contact:** Call (847) 570-4224 with questions regarding the study.

#### **Single Level: Clinical Study Protocol for the Investigation of the Simplify® Cervical Artificial Disc**

**Aims:** This nonrandomized study evaluates the safety and effectiveness of the Simplify Disc for patients who are undergoing a discectomy (removal of a cervical disc) at one level due to arm pain and/or neurological symptoms (such as weakness or numbness). The study is for patients with or without neck pain who have specific findings on imaging studies such as X-ray, CT or MRI. The study is for patients who have tried but have not responded to at least six weeks of non-surgical care such as physical therapy, medicines or injections or have increasing symptoms, such as numbness or tingling, and/or who have signs of nerve compression in the part of the nerves that branches out from the spinal cord. This research study will compare outcomes after surgery with the Simplify Disc to historical outcomes after anterior cervical discectomy and fusion (ACDF) surgery.

**Principal Investigator:** Michael Musacchio, MD  
**NorthShore Project Number:** EH16-125  
**Contact:** Call (847) 570-4224 with questions regarding the study.

#### **A 2- and 5-Year Comparative Evaluation of Clinical Outcomes in the Treatment of Degenerative Spinal Stenosis with Concomitant Low Back Pain by Decompression with and without Additional Stabilization Using the coflex® Interlaminar Technology for FDA Conditions of Use Study**

**Aims:** This is a prospective, multicenter, randomized, controlled and patient-blinded study with the purpose of demonstrating the safety and effectiveness of the coflex device in conjunction with surgical decompression relative to decompression alone. The study is for patients from 40 to 80 years of age who have tried but have not responded to at least one epidural injection at any prior time point, and at least 6 months of prior conservative care without adequate and sustained symptom relief. The coflex Interlaminar Technology is intended for use as a permanent implant between the lamina of one or two lumbar motion segments in the treatment of at least moderate leg and low back pain in patients with moderate to severe spinal stenosis. The device is specifically designed to provide stabilization without fusion in cases of stenosis. It is restricted for use to one or two levels in the region of L1-L5. This research study will compare and evaluate 2- and 5-year clinical outcomes of patients implanted with the coflex device in conjunction with surgical decompression with those treated with decompression alone.

**Principal Investigator:** Michael Musacchio, MD  
**NorthShore Project Number:** EH16-184  
**Contact:** Call (847) 570-4224 with questions regarding the study.

### **Stroke Program Clinical Trials**

#### **Platelet-Oriented Inhibition in New TIA and Minor Ischemic Stroke (POINT) Trial**

**Aims:** The purpose of this study is to determine whether clopidogrel 75 mg/day by mouth after a loading dose of 600 mg of clopidogrel is effective in preventing major ischemic vascular events (ischemic stroke, myocardial infarction and ischemic vascular death) at 90 days when initiated within 12 hours of transient ischemic attack (TIA) or minor ischemic stroke onset in patients receiving aspirin 50-325 mg/day (with a dose of 162 mg daily for 5 days followed by 81 mg daily strongly recommended).

**Principal Investigator:** Archie Ong, MD  
**NorthShore Project Number:** EH11-057  
**Contact:** Call (847) 503-4322 with questions regarding the study.

#### **MISTIE III: A Phase III, Randomized, Open-Label, 500-Subject Clinical Trial of Minimally Invasive Surgery Plus rt-PA in the Treatment of Intracerebral Hemorrhage**

**Aims:** The purpose of this study is to determine the safety and effectiveness of an emergency treatment for intracerebral hemorrhage (spontaneous bleeding in the brain) compared to the current standard of care. The investigational treatment involves a procedure to remove the blood clot in the brain through a small tube, and the use of a drug called rt-PA to break up the clot and further aid in its removal. Study participants will be randomly assigned to either the investigational treatment or current standard of care, which does not include removal of the clot.

**Principal Investigator:** Shakeel Chowdhry, MD  
**NorthShore Project Number:** EH13-028  
**Contact:** Call (847) 570-4224 with questions regarding the study.

#### **ENRICH (Early miNimally-invasive Removal of ICH)**

**Aims:** The purpose of this study is to provide clinical evidence of functional improvement, safety and economic benefit when comparing intracerebral hemorrhage (ICH) evacuation (removal of a blood clot from the brain using the minimally invasive BrainPath access system) to medical treatment.

**Principal Investigator:** Shakeel Chowdhry, MD  
**NorthShore Project Number:** EH17-038  
**Contact:** Call (847) 570-4224 with questions regarding the study.



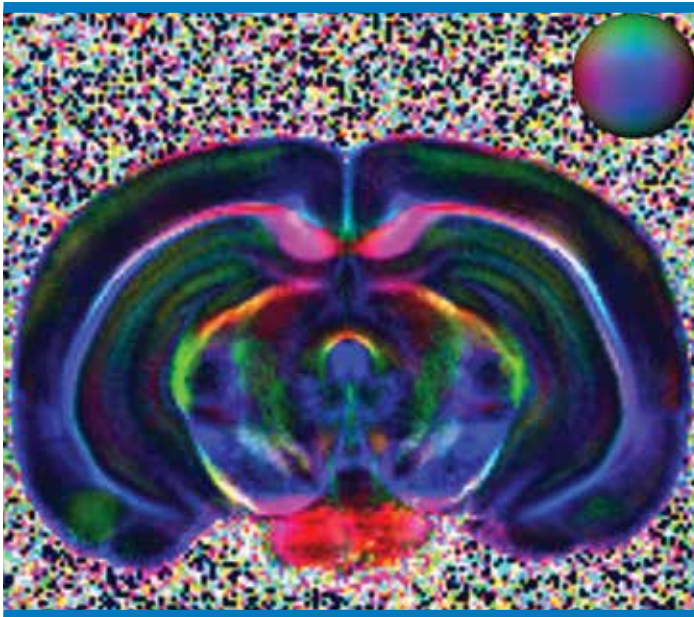
## Traumatic Brain Injury Research

The Traumatic Brain Injury (TBI) Laboratory at NorthShore Neurological Institute has a number of projects currently underway to understand the TBI mechanisms and to test strategies to prevent injury. The laboratory is equipped with multiple preclinical models to translate new discoveries up to human clinical trials. Some of the current projects are detailed here.

### ■ Diffusion Tensor Imaging After Blast Injury

From 2000 through 2012, more than 300,000 service members sustained a blast traumatic brain injury (TBI) while on active duty, making blast TBI the “signature wound” of the wars in Iraq and Afghanistan. Since 2000, the U.S. government has spent about \$1.5 billion in blast TBI research and about \$6 billion on health-care expenditures. Blast TBI presents a daunting challenge for the military medical community.

A TBI caused by an explosion or blast can be more complex compared with a TBI from other causes, like from a car crash or sports injury. A non-impact, blast-induced mild TBI is caused by the exposure to an over-pressure wave that is generated by the blast itself. More serious TBI is caused by the penetrating and blunt impact injuries that are caused by secondary and tertiary blast effects such as shrapnel and objects impacting the head. People who sustain blast-induced mild TBI have persistent symptoms including headache, dizziness, memory loss, attention deficit, sleep difficulties, blurred vision or tired eyes, ringing in the ears, and hearing loss and may continue developing Alzheimer’s-like dementia and Parkinson’s disease.



Mouse brain image acquired ex vivo on the 14.1 T microimager after blast injury. DTI results show directionality of fiber orientation with color-coding in three orthogonal directions.

“The TBI Laboratory at NorthShore Neurological Institute is one of a select few places in the country with the resources and expertise to advance new solutions to the TBI problem.”

— Dr. Julian Bailes



There is still a lot to learn about the true mechanism of blast-induced TBI, and personal blast protection against TBI is still the most difficult challenge facing medical researchers and body armor engineers. Currently, fielded body armor is unable to properly protect the human body against the impact of blast shock wave. However, researchers at the TBI Laboratory at NorthShore are meeting these challenges by testing innovative strategies to investigate blast-induced TBI in an experimental model called a shock tube, which generates a blast over-pressure wave in a laboratory setting. Researchers at the TBI Laboratory then use the most advanced neuroimaging technology, such as diffusion tensor imaging (DTI), to visualize the injury and use it as a biomarker.

DTI is an advanced MRI method that can image brain injuries at a microstructural level and is sensitive enough to detect nerve fiber injury and integrity of mild, moderate and severe TBI. In preliminary experiments, researchers at the TBI Laboratory at NorthShore Neurological Institute have found that orientation and integrity of nerve fiber tracts decreased in certain areas of the brain after a single blast (see image to the left). With repetitive blasts, it is postulated that this injury will become more severe and additional regions of the brain would also be affected. Neuroimaging such as this can be studied to test strategies to mitigate the injury.

# Research Highlights

## ■ Severe Traumatic Brain Injury Research

Death resulting from severe traumatic brain injury (TBI) is a rare but catastrophic and unfortunate occurrence in military combat and contact sports, particularly football. According to the National Center for Catastrophic Sport Injury Research, seven deaths occurred in 2015 as a direct result of playing football. New research recently published by researchers at NorthShore Neurological Institute provides clues to help mitigate these deaths.

Efforts aimed at preventing TBI in at-risk populations such as military personnel and athletes have continued to focus on improved helmet technology. However, although helmets are effective in preventing fractures of the skull, they have little effect on other mechanisms of TBI. This is because the brain floats inside the skull in fluid so that it does not completely fill the skull cavity.

When the brain undergoes a rapid and sudden acceleration and deceleration, which occurs during a concussive injury, it can continue its momentum, hitting the inside of the skull stretching and tearing brain fibers, resulting in the symptoms of concussion. Julian Bailes, MD—Surgical Director of NorthShore Neurological Institute and a nationally recognized leader in research on the impact of brain injury on brain function—refers to this phenomenon as “brain slosh.”

Apart from these microscopic injuries, brain slosh can also cause rare but severe TBI injuries such as brain bleeds, which

are the cause of many catastrophic TBI events seen in combat and as a direct result of playing football over the years.

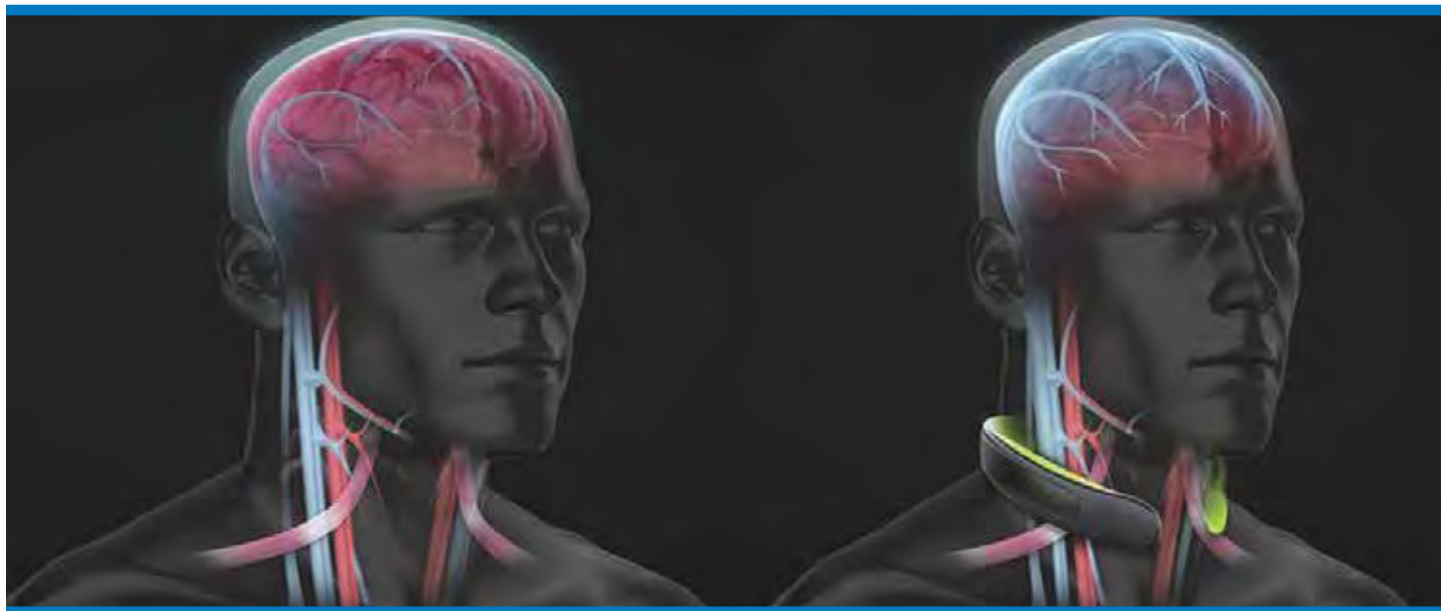
Dr. Bailes and co-researchers at the TBI Laboratory at NorthShore Neurological Institute are currently testing an innovative strategy designed to mitigate brain slosh effect—and subsequent TBI—using a collar.

The collar mildly applies pressure on the internal jugular veins (IJVs) in the neck to produce a small increase of blood volume in the brain and thus reduce its movement (see image below).

Previously published preclinical studies found that the collar produced a significant reduction in the number of torn brain fibers in a standard laboratory rodent concussion model. However, research performed in the TBI Laboratory study and recently published in the *Journal of Neurotrauma* showed that the amount of brain bleed was also reduced in a severe TBI model when the collar was applied.

When discussing the results of this latest research, Dr. Bailes said, “This study raises the question of whether severe or lethal brain injury from acceleration-deceleration forces would also be positively affected by elevation of brain blood volume through mild IJV compression prior to injury.”

So far, the research and their findings are preliminary. Further work needs to be conducted to determine the effectiveness and safety of this method in those at risk of severe TBI such as athletes, as well as active soldiers.



**(left) Visual representation of the jugular vein in the neck and the veins in the brain shown in blue. (right) Visual representation of the collar application located near the neck muscle overlying the jugular vein. The slight widening of the jugular vein above the collar results in backfilling of the veins in the brain providing the hypothesized tighter fit of the brain inside the skull.** (Image from Myer et al. *Br J Sports Med*. 2016)

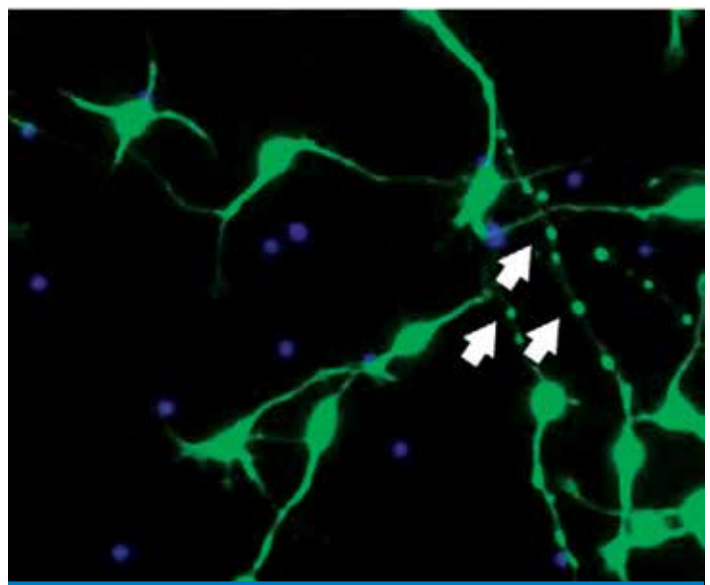
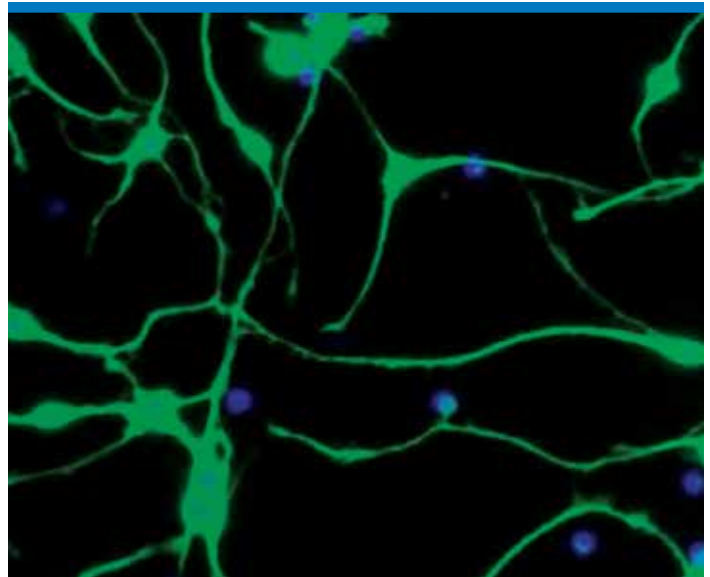
# Research Highlights

## High-Throughput Screening for TBI Therapeutics

There are limited therapeutic options for TBI since more than 30 clinical trials have been conducted in TBI, and all have failed. This may be because preclinical tools capable of screening potential therapeutic compounds are not currently available for TBI. At the TBI Laboratory, researchers have developed a new tool to address this gap that is hoped to accelerate new discoveries in TBI therapeutics.

A report describing this model was recently published in the journal *Scientific Reports*. John Finan, PhD, is the biomedical engineer in the Department of Neurosurgery and principal investigator on the project. Dr. Finan was recently awarded federal funding from the National Institute of Neurological Disorders and Stroke to further develop this model. Dr. Finan says, “The human brain is soft and heavy, and it shears under its own weight when the head is violently accelerated. This motion stretches neurites, causing a traumatic axonal injury (TAI)—an important component of severe TBI pathology.”

The new, custom-built tool is engineered to mimic this stretching injury in a cell-based test (see image to the right). Dr. Finan plans to convert this test into a high-throughput screening (HTS) method that can be used for drug discovery. HTS assays are performed in automation-friendly microtiter plates with a 96-well format so as to quickly test the biological or biochemical activity of a large number of compounds. Even the image analysis is computerized to track the injury.



(Top panel) Image of live (green) and dead (purple) neurons in a 96-well microtiter plate before a stretching injury was applied. The neurites (projections from the neurons) are large and thick. (Bottom panel) Same cells four hours after a stretch injury results in an increase in neuronal cell death and shorter and thinner neurites with beads (arrows). From *Scientific Reports* 2016;6:34097.



**“This tool will allow us to screen thousands of potential therapeutic compounds to identify those that can rescue neurons after traumatic injury.”** — Dr. John Finan



# Research Highlights

## The DodoNA Project

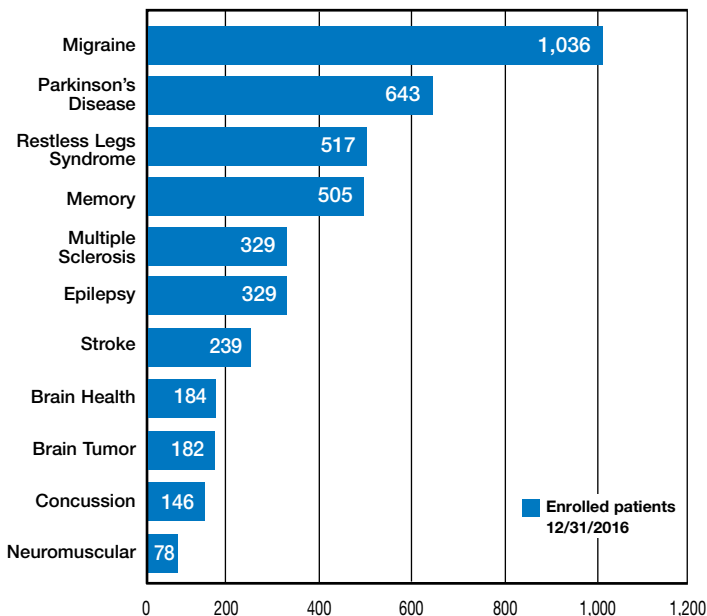
**The DodoNA project is one of the major research initiatives of NorthShore Neurological Institute. The purpose of the project is to predict, prevent and halt neurological disorders through the development of DNA-based prognostic tests and therapies (see page 18 for more details).**

The DodoNA researchers built customized “toolkits” within NorthShore’s award-winning Electronic Medical Record (EMR) system for each of the 11 disorders that capture and store data from routine office visits. The researchers are also collecting blood and extracting DNA and plasma to be stored in a biobank. Laboratory scientists will then perform automated DNA sequencing tests to define DNA “fingerprints,” which statisticians will then associate with disease outcomes and therapeutic responses. With this information, researchers will be in a better position to deliver methods to predict and modify disease.

### Research Update

As of December 31, 2016, we have enrolled more than 4,000 patients in the DodoNA project, and we are well on our way to reaching the 11,000 target total. Several hundred thousand

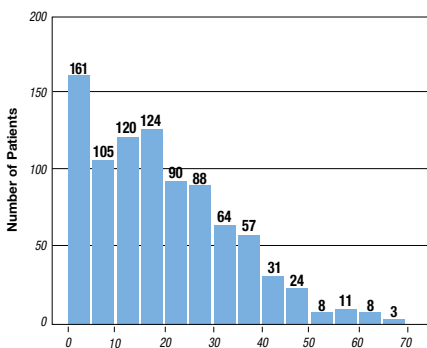
discrete data points have been collected and analyzed by DodoNA researchers. In summer 2016, we launched our Neuromuscular project.



## Migraine Description of our first 1,001 patients enrolled, at their initial visit

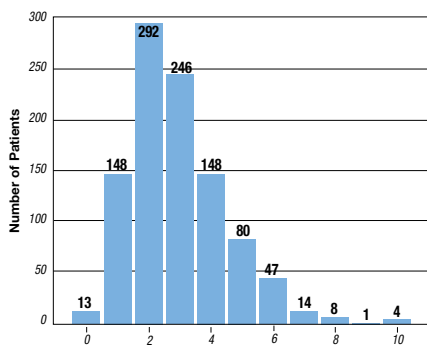
### Disease Duration

Measured in years, from year of initial symptom to year of initial visit.



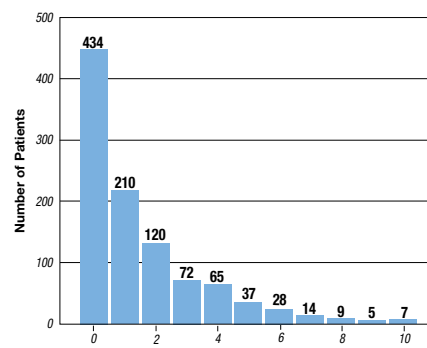
### Number of Prior Abortive Medications

Abortive medications are taken at the start of a migraine attack to stop the symptoms.



### Number of Prior Preventive Medications

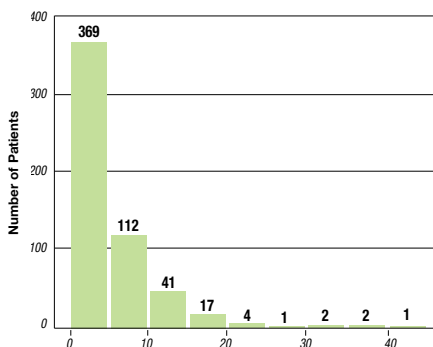
Preventive medications are taken daily to keep migraine attacks from occurring frequently.



## Parkinson's Disease Description of our first 627 patients enrolled, at their initial visit

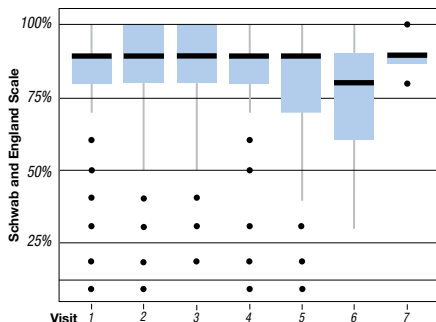
### Disease Duration

Measured in years, from year of initial symptom to year of initial visit.



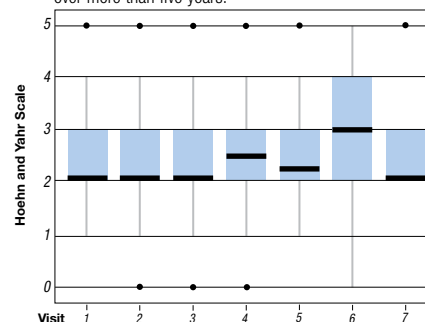
### Longitudinal Changes in Schwab and England Scale

Patients self-report their abilities to perform activities of daily living. One hundred percent indicates a completely independent individual, and 0% indicates a completely nonfunctioning individual.



### Longitudinal Changes in Hoehn and Yahr Scale

The Hoehn and Yahr scale is a measure of motor impairment; it is an objective measure of disability. As a group, our patients have remained largely stable over more than five years.

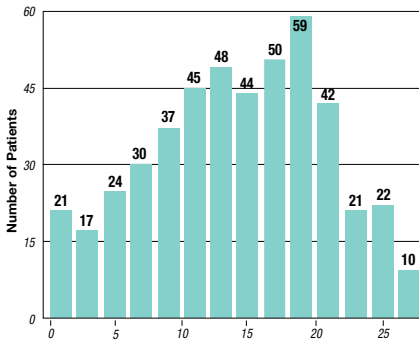


# Research Highlights

## Restless Legs Syndrome *Description of our first 506 patients enrolled, at their initial visit*

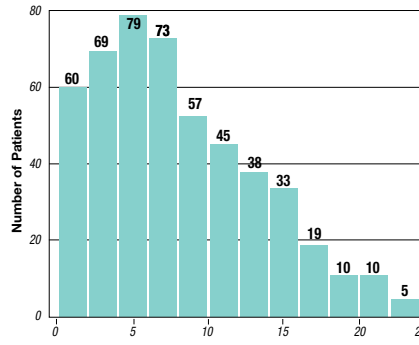
### ISI Score

Insomnia Severity Index (ISI), where scores of 15 and over indicate at least moderate severity.



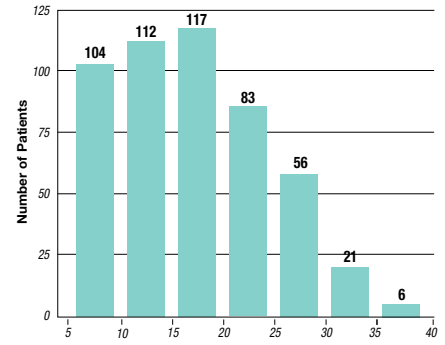
### ESS Score

Epworth Sleepiness Scale (ESS), where scores greater than 10 indicate excessive daytime sleepiness.



### IRLS Score

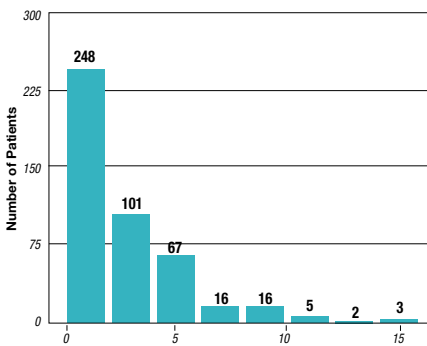
International Restless Legs Scale (IRLS) rating scale, where scores of 0-10 = mild, 11-20 = moderate, 21-30 = severe and 31-40 = very severe.



## Memory *Description of our first 478 patients enrolled, at their initial visit*

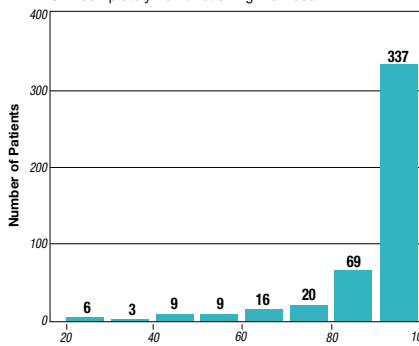
### Disease Duration

Measured in years, from year of initial symptom to year of initial visit.



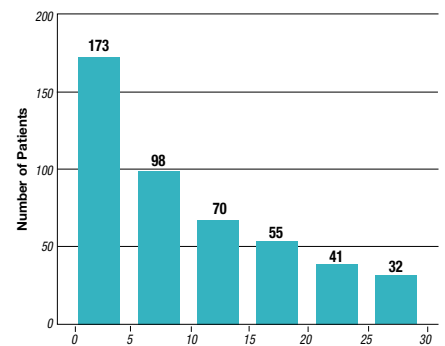
### Barthel Index

A measure of performance in activities of daily living (basic activities). 100 = completely independent individual; 0 = completely nonfunctioning individual.



### The Functional Activities Questionnaire

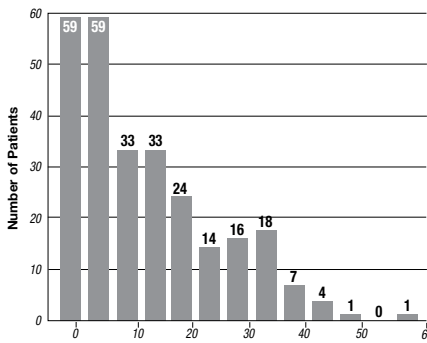
A measure of performance in activities of daily living (complex activities). 0 = person with no limitations; 30 = fully dependent individual.



## Multiple Sclerosis *Description of our first 319 patients enrolled, at their initial visit*

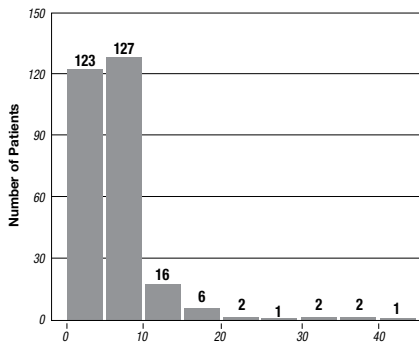
### Disease Duration

Measured in years, from year of initial symptom to year of initial visit.



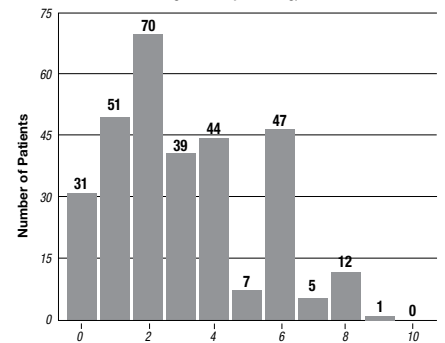
### 25 ft. Walk

The number of seconds required, on a second attempt, to walk 25 feet.



### EDSS Step

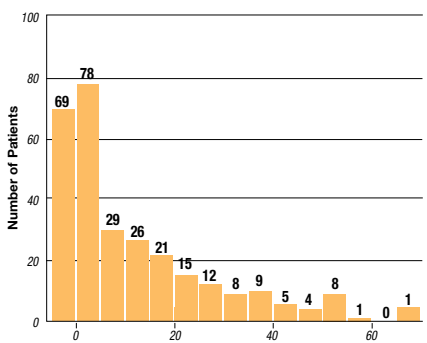
Expanded Disability Status Scale (EDSS), where higher scores are more severe (e.g., scores of 5 and above indicate increasing difficulty walking).



## Epilepsy *Description of our first 314 patients enrolled, at their initial visit*

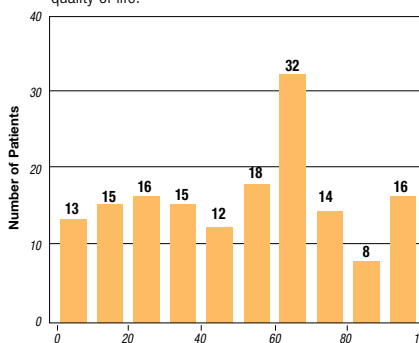
### Disease Duration

Measured in years, from year of initial symptom to year of initial visit.



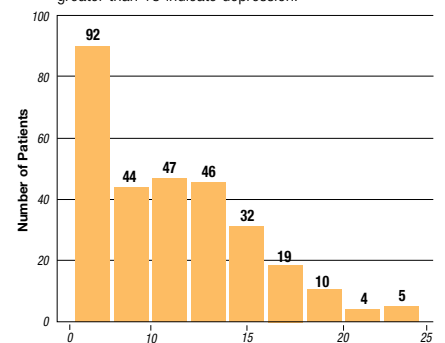
### QOLIE Total Score

Quality of Life in Epilepsy (QOLIE-10-P). Lower scores indicate a greater severity and burden of epilepsy on quality of life.



### NDDI-E Total Score

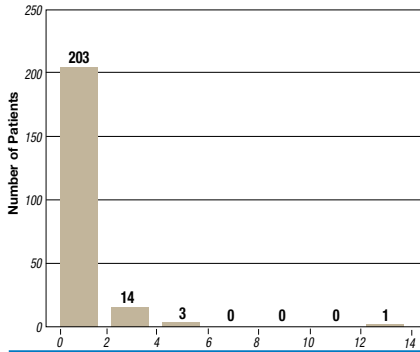
The Neurological Disorders Depression Inventory for Epilepsy (NDDI-E) is a 6-item questionnaire validated to screen for depression in people with epilepsy. Scores greater than 15 indicate depression.



**Stroke** Description of our first 225 patients enrolled, at their initial visit

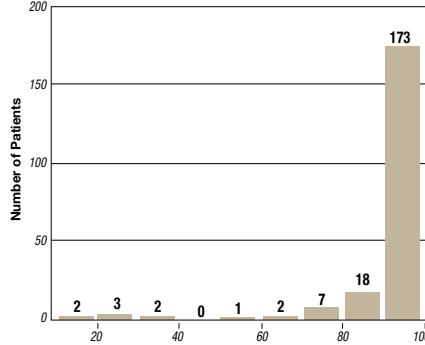
**National Institutes of Health Stroke Scale (initial)**

An objective measure of the severity of strokes. 0 = no symptoms, 1-4 = mild stroke; 5-15 = moderate stroke.



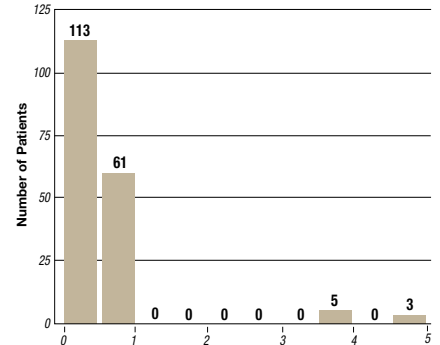
**Barthel Index**

A measure of performance in activities of daily living (basic activities). 100 = completely independent individual; 0 = completely nonfunctioning individual.



**Modified Rankin Index**

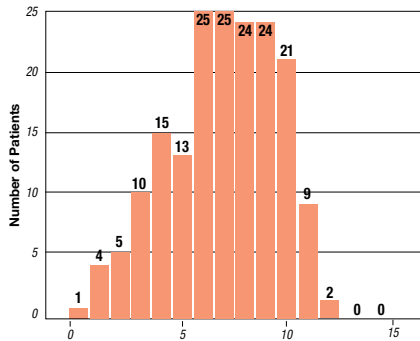
A global disability scale. 0 = no symptoms; 5 = severe disability.



**Brain Health** Description of our first 179 patients enrolled, at their initial visit

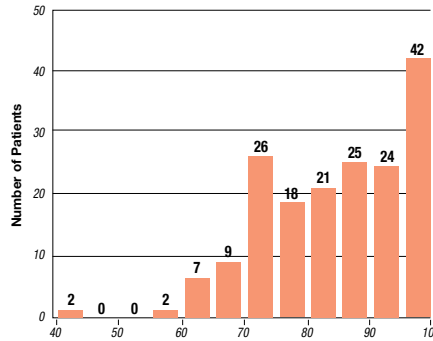
**PREDIMED Questionnaire**

The PREDIMED questionnaire is a 14-item quiz that defines adherence to the Mediterranean diet. 0-9 = weak adherence; 10-14 = strong adherence.



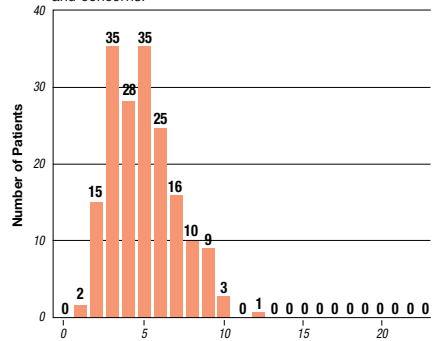
**Readiness Questionnaire**

The readiness questionnaire indicates readiness to engage in several brain health activities. 100 = very willing for every activity; 0 = very unwilling for all activities.



**Brain Health Quiz Score**

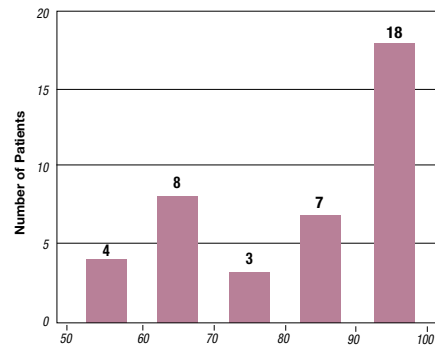
The brain health quiz includes 23 well-defined risk factors for Alzheimer's disease and related disorders. 0 = no risk factors or concerns; 23 = all risk factors and concerns.



**Brain Tumor (primary malignant)** Description of our first 40 patients enrolled, at their initial visit

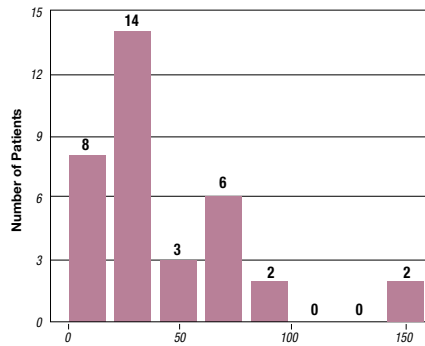
**Karnofsky Performance Scale**

Classification of functional impairment used to compare effectiveness of different therapies. The lower the score, the worse the survival for most serious illnesses.



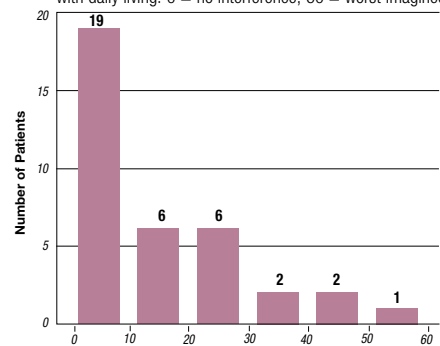
**MD Anderson Symptom Inventory—Brain Tumor (Part 1)**

Measures a patient's self-reported symptoms severity, 0 = no symptoms; 220 = worst imagined.



**MD Anderson Symptom Inventory—Brain Tumor (Part 2)**

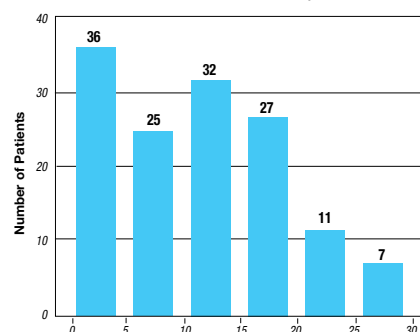
Measures how a patient's symptoms reportedly interfere with daily living. 0 = no interference; 60 = worst imagined.



**Concussion** Description of our first 142 patients enrolled, at their initial visit

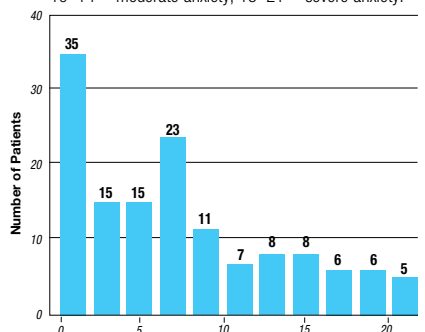
**ISI Score**

Insomnia Severity Index (ISI), where scores of 15 and over indicate at least moderate severity.



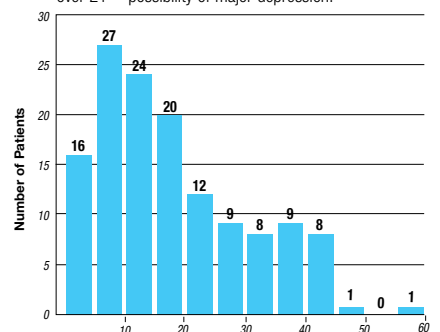
**GAD-7 Score**

Measuring of generalized anxiety disorder (GAD). 0-4 = minimal anxiety; 5-9 = mild anxiety, 10-14 = moderate anxiety; 15-21 = severe anxiety.



**CES-D Score**

Screening test to determine depression quotient. 15-21 = mild to moderate depression; over 21 = possibility of major depression.





# Research Highlights

## Neurology Practice-Based Research Network (NPBRN)



### From Best Practices to Next Practices

The mission of NorthShore Neurological Institute is “to preserve and improve neurological health through clinical practice, education and research.” In keeping with this mission, the Neurology Practice-Based Research Network (NPBRN) was launched in June 2015.

The goal of the NPBRN is to advance quality improvement and practice-based research in neurology using the Electronic Medical Record (EMR) system. The principal investigator of the project is Demetrius Maraganore, MD.



Currently, there is a lack of quality initiatives and comparative effectiveness research in neurology. To address this gap, the American Academy of Neurology (AAN) has published evidence-based guidelines, quality improvement measures and resources for treating neurological disorders. However, there are few tools available to standardize neurology office visits according to these guidelines.

In 2003, NorthShore was among the first in the country to successfully launch a systemwide EMR, called “Epic,” with demonstrable benefits in quality, safety, efficiency and service to patients. NorthShore is recognized by multiple national organizations for this notable achievement. The Department of Neurology at NorthShore has invested heavily and built, into Epic, tools that meet AAN guidelines, standardize care, write progress notes and capture up to 1,000 discrete data points per office visit. These EMR toolkits have so far been applied to 10 common neurological disorders plus brain health (11 toolkits total).

### Neurology Practice-Based Research Network Sites Progress

NPBRN Site	Number of Toolkits Planned or Implemented (Out of 11)
Dartmouth-Hitchcock	3
Medical University of South Carolina	3
NorthShore University HealthSystem	11
Ochsner Health System	11
St. Luke’s Hospital (MO)	6
University of Arkansas	4
University of Cincinnati	4
University of Florida	8
University of Michigan	3
University of Nebraska	6
University of Pennsylvania	6
Wake Forest University	4

### NPBRN Sites

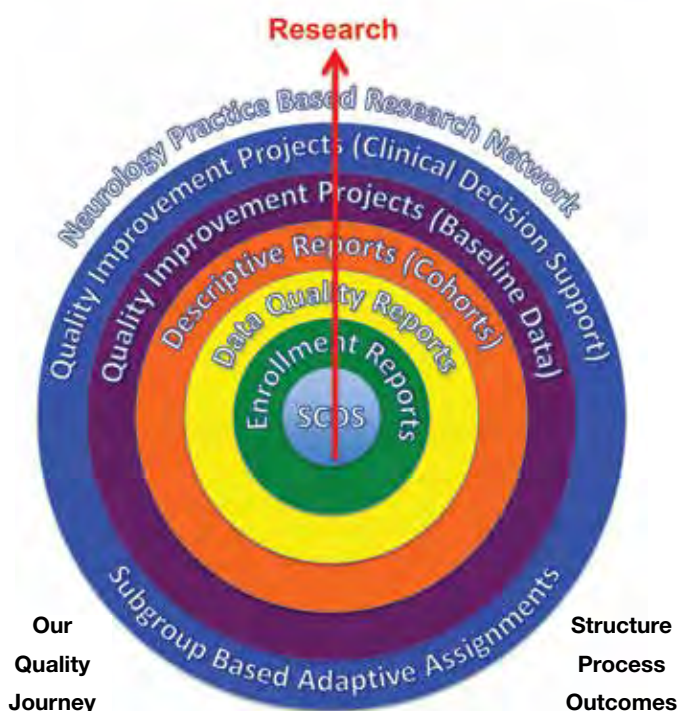
Dr. Maraganore has been successful in obtaining federal support for the NPBRN in the form of a \$1.2 million multiyear award from the Agency for Healthcare Research and Quality (AHRQ). The AHRQ award, titled “Quality Improvement and Practice-Based Research in Neurology Using the EMR,” has two specific aims. The first is to establish the NPBRN at multiple sites by sharing our proprietary EMR tools for 10 common neurological disorders plus brain health (11 toolkits total) with other neurology practices nationwide that also use the Epic EMR system. Sharing EMR tools in this way will not only foster collaboration, but increase the amount of data the project will be able to generate. In response to the initial call by Dr. Maraganore to participate in the NPBRN, seven institutions in addition to NorthShore agreed to join in 2015 and four more joined in 2016 (12 sites total). Once fully implemented, the tools will capture and share de-identified data from each of these visits to support quality improvement efforts.

## Our Quality Journey

The Department of Neurology at NorthShore includes more than 40 neurologists practicing at four hospitals and multiple outpatient sites in the north suburbs of Chicago.

Dr. Maraganore and co-authors presented a step-by-step description of the establishment of the NPBRN for 11 projects: brain tumors, epilepsy, migraine, memory disorders, mild traumatic brain injury, multiple sclerosis, neuropathy, Parkinson's disease, restless legs syndrome, stroke and brain health. A graphic of our quality journey is shown below and includes:

- Step 1:** Development and implementation of structured clinical documentation support (SCDS)–EMR–tools
- Step 2:** Enrollment reports of subjects encountered (up to 1,000 fields of data captured per office visit)
- Step 3:** Data quality reports to identify missing data
- Step 4:** Descriptive reports of group characteristics such as patient reported and physician assessment measures
- Step 5:** Quality improvement projects (baseline measures)
- Step 6:** Quality improvement projects (using clinical decision-support tools built into the EMR to hardwire patient safety and improve outcomes)
- Step 7:** Dissemination of tools and sharing of data via the NPBRN.



## Comparative Effectiveness Research

An important component of the NPBRN is that we will be able to perform, for the first time, pragmatic clinical trials using the EMR in neurology to compare the effectiveness of several available therapies. These trials will be conducted using a subgroup-based adaptive (SUBA) design, an innovative way to inform healthcare decisions using precision medicine and provide evidence on the effectiveness, benefits and drawbacks of different treatment options. The plan is to perform 11 SUBA trials—one for each NPBRN project—with a total of 3,300 patients.

In July 2016, we launched the first of these trials in the migraine NPBRN project where we will be comparing the effectiveness of three preventive medications for migraine headaches.

For this trial, we randomly assigned the first 120 patients to one of the three migraine medications. We have integrated SUBA within the EMR software so that data captured from these first 120 patients will identify subgroup effects and assign 200 newly enrolled patients—in real time—to treatments that are expected to be more effective and achieve the best outcomes.

**“For precision medicine, the launch of these first trials is a Kitty Hawk moment. Through this innovative use of the EMR, we will identify the most effective treatments for common neurological disorders.”**

— Dr. Demetrius Maraganore

In December 2016, we launched a second pragmatic trial comparing three memory-enhancing drugs in patients with mild cognitive impairment.

To increase the “learning” of the computerized system, we will continually capture outcomes data at initial and annual visits over five years whereas most clinical trials follow patients only up to a year.

Additionally, we will enroll eligible patients to provide a DNA sample and will assay the samples for up to 1 million genetic variations. We will associate the genotypes with the longitudinal outcomes captured by the EMR tools (see The DodoNA Project on pages 25, 26 and 27).

## [Brainstem Monitoring in the Neurocritical Care Unit: A Rationale for Real-Time, Automated Neurophysiological Monitoring.](#)

Stone JL, Bailes JE, Hassan AN, Sindelar B, Patel V, Fino J. *Neurocrit Care*. 2017 Feb;26(1):143-156. doi: 10.1007/s12028-016-0298-y. PMID: 27484878

## [Structured clinical documentation in the electronic medical record to improve quality and to support practice-based research in epilepsy.](#)

Narayanan J, Dobrin S, Choi J, Rubin S, Pham A, Patel V, Frigerio R, Maurer D, Gupta P, Link L, Walters S, Wang C, Ji Y, Maraganore DM. *Epilepsia*. 2017 Jan;58(1):68-76. doi: 10.1111/epi.13607. PMID: 27864833

[Football Fatalities: The First-Impact Syndrome.](#) Bailes JE, Patel V, Farhat H, Sindelar B, Stone J. *J Neurosurg Pediatr*. 2017 Jan;19(1):116-121. doi: 10.3171/2016.8.PEDS16355. No abstract available. PMID: 27791701

## [Fusiform Left Carotid-Ophthalmic Artery Aneurysm Presenting with Central Retinal Artery Occlusion.](#)

Dafer RM, Pula JH, Chowdhry S. *J Stroke Cerebrovasc Dis*. 2017 Jan;26(1):e25-e26. doi: 10.1016/j.jstrokecerebrovasdis.2016.10.024. PMID: 27865695

## [Evaluation of the interaction between LRRK2 and PARK16 loci in determining risk of Parkinson's disease: analysis of a large multicenter study.](#)

Wang L, Heckman MG, Aasly JO, Annesi G, Bozi M, Chung SJ, Clarke C, Crosiers D, Eckstein G, Garraux G, Hadjigeorgiou GM, Hattori N, Jeon B, Kim YJ, Kubo M, Lesage S, Lin JJ, Lynch T, Lichtner P, Mellick GD, Mok V, Morrison KE, Quattrone A, Satake W, Silburn PA, Stefanis L, Stockton JD, Tan EK, Toda T, Brice A, Van Broeckhoven C, Uitti RJ, Wirdefeldt K, Wszolek Z, Xiromerisiou G, Maraganore DM, Gasser T, Krüger R, Farrer MJ, Ross OA, Sharma M; GEOPD Consortium. *Neurobiol Aging*. 2017 Jan;49:217.e1-217.e4. doi: 10.1016/j.neurobiolaging.2016.09.022. PMID: 27814993

## [Efficacy and safety results of ABT-414 in combination with radiation and temozolomide in newly diagnosed glioblastoma.](#)

Reardon DA, Lassman AB, van den Bent M, Kumthekar P, Merrell R, Scott AM, Fichtel L, Sulman EP, Gomez E, Fischer J, Lee HJ, Munasinghe W, Xiong H, Mandich H, Roberts-Rapp L, Ansell P, Holen KD, Gan HK. *Neuro Oncol*. 2016 Dec 29. pii: now257. doi: 10.1093/neuonc/now257. [Epub ahead of print] PMID: 28039367

## [Effect of Internal Jugular Vein Compression on Intracranial Hemorrhage in a Porcine Controlled Cortical Impact Model.](#)

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# Physician Directory

## Neurologists



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*Medical Director, NorthShore Neurological Institute*  
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# Physician Directory

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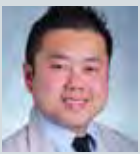
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**Danielle Schiff, MD**

*Director, PM&R Inpatient Rehabilitation  
Expertise: Physical Medicine and Rehabilitation, Lymphedema  
Locations: EV, GVP, HP*

**Naila Shaikh, MD**

*Expertise: Physical Medicine and Rehabilitation, Women's Health Issues, Cancer Rehabilitation  
Location: EV*

## Neuropathologist

**John Lee, MD, PhD**

*Director, Residency Program, Department of Pathology  
Expertise: Neuropathology, Pathology  
Location: EH*

continued >>

# Physician Directory

## Neuropsychologists

**Jerry Sweet, PhD**

*Vice Chair, Department of Psychiatry and Behavioral Sciences*  
*Expertise:* Concussion, Dementias, Memory Disorders,  
Traumatic Brain Injury  
*Location:* DS

**Laura Benson, PhD**

*Expertise:* Adult Neuropsychology, Memory Disorders, Dementias,  
Neurologic Disorders, Concussion/Traumatic Brain Injury,  
Attention-Deficit/Hyperactivity Disorder (ADHD)/Learning Disorders,  
Psychiatric Conditions  
*Locations:* GB, GU

**Elizabeth Geary, PhD**

*Expertise:* Dementia, Epilepsy, Movement Disorder, Multiple  
Sclerosis (MS), Traumatic Brain Injury  
*Locations:* DS, GB

**Leslie Guidotti Breting, PhD**

*Expertise:* Alzheimer's Disease, Attention Deficit Hyperactivity  
Disorder (ADHD), Concussion, Dementia, Epilepsy/Seizure Disorder,  
Learning Functioning, Memory Disorders, Neurological Disorders  
*Location:* DS

**Elizabeth Hartman, PhD**

*Expertise:* Adult Neuropsychology, Alzheimer's Disease, Attention  
Deficit Hyperactivity Disorder (ADHD), Concussion/Traumatic Brain  
Injury, Dementias, Memory Disorders, Neurological Disorders,  
Psychiatric Conditions  
*Locations:* DF, GU

**Elizabeth Heideman, PhD**

*Expertise:* Anxiety, Attention Deficit Hyperactivity Disorder (ADHD),  
Concussion, Depression, Learning Functioning, Neurological  
Disorders, Pediatric Epilepsy, Pediatric Genetic Disorders  
*Locations:* DS, GV

**Marietta Hoogs, PhD**

*Expertise:* Alzheimer's Disease, Attention Deficit Hyperactivity  
Disorder (ADHD), Dementias, Neurological Disorders, Learning  
Functioning  
*Locations:* GB, DF

**Lizabeth Jordan, PhD**

*Expertise:* Pediatric Neuropsychology, Developmental Disorders,  
Childhood Brain Injuries, Pediatric Epilepsy/Seizure Disorders  
*Locations:* GU, GV

**Elizabeth Pieroth, PsyD**

*Associate Director, Sports Concussion*  
*Expertise:* Concussion, Sports Concussion, Traumatic Brain Injury  
*Locations:* GB, OB

**Alona Ramati, PhD**

*Expertise:* Alzheimer's Disease, Attention Deficit Hyperactivity  
Disorder (ADHD), Concussion, Dementias, Epilepsy/Seizure  
Disorder, Learning Disorders, Learning Functioning, Memory  
Disorders, Movement Disorders, Multiple Sclerosis (MS),  
Parkinson's Disease (PD), Stroke, Traumatic Brain Injury  
*Location:* GB

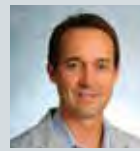
**Victoria Tuchscherer, PhD**

*Expertise:* Autism Spectrum Disorder, Attention Deficit  
Hyperactivity Disorder (ADHD), Learning Deficits, Traumatic  
Brain Injury, Anxiety/Depression, Pediatric Epilepsy,  
Hydrocephalus, Pediatric Genetic Disorders  
*Locations:* DF, GB

## Neuroradiologists

**Matthew Walker, MD**

*Head, Division of Neuroradiology,*  
*Department of Radiology*  
*Expertise:* Neuroradiology  
*Location:* EH

**William Ankenbrandt, MD**

*Expertise:* Neuroradiology,  
Interventional Radiology  
*Location:* EH

**Anne Doppenberg, MD**

*Expertise:* Neuroradiology  
*Locations:* EH, HPH

**Kenneth Goldberg, MD**

*Expertise:* Neuroradiology  
*Location:* EH

**Michael Gorey, MD**

*Expertise:* Neuroradiology  
*Location:* EH

**Joel Meyer, MD**

*Expertise:* Neuroradiology  
*Location:* EH

**Kristina Olsen, MD**

*Expertise:* Neuroradiology  
*Location:* EH

**Bojan Petrovic, MD**

*Expertise:* Neuroradiology  
*Location:* EH

**Jordan Prager, MD**

*Expertise:* Neuroradiology  
*Location:* EH

**Doris Yip, MD**

*Expertise:* Neuroradiology  
*Location:* EH



# Locations

**Chicago Lake Shore Medical Office (CH)**

680 North Lake Shore Drive, Suite 924, Chicago, IL 60611

**NorthShore Medical Group (DF)**

49 South Waukegan Road, Suite 200, Deerfield, IL 60015

**NorthShore Medical Group (DS)**

909 Davis Street, Suite 160, Evanston, IL 60201

**Evanston Hospital (EH)**

2650 Ridge Avenue, Evanston, IL 60201

**Evanston Neurological Institute (EV)**

1000 Central Street, Suite 880, Evanston, IL 60201

**Evanston Kellogg Cancer Center (EVK)**

2650 Ridge Avenue, Evanston, IL 60201

**Glenbrook Ambulatory Care Center (GB)**

2180 Pfingsten Road, Suite 2000, Glenview, IL 60026

**Glenbrook Eye and Vision Center (GBE)**

2050 Pfingsten Road, Suite 280, Glenview, IL 60026

**Glenbrook Kellogg Cancer Center (GBK)**

2180 Pfingsten Road, Suite 1000, Glenview, IL 60026

**Glenbrook Specialty Suites (GBSS)**

2150 Pfingsten Road, Suite 3000, Glenview, IL 60026

**NorthShore Medical Group (GV)**

2300 Lehigh Avenue, Suite 215, Glenview, IL 60026

**Gurnee Ambulatory Care Center (GR)**

7900 Rollins Road, Gurnee, IL 60031

**NorthShore Medical Group (GU)**

200 South Greenleaf Street, Suite E, Gurnee, IL 60031

**Glenview Park Center (GVP)**

2400 Chestnut Avenue, Glenview, IL 60026

**Highland Park Specialty Care Center (HP)**

757 Park Avenue West, Suite 2850, Highland Park, IL 60035

**Highland Park Hospital (HPH)**

777 Park Avenue West, Highland Park, IL 60035

**Highland Park Kellogg Cancer Center (HPK)**

777 Park Avenue West, Highland Park, IL 60035

**Lincolnshire Medical Group (LS)**

920 Milwaukee Avenue, 2nd Floor, Lincolnshire, IL 60069

**NorthShore Medical Group (OB)**

700 Commerce Drive, Suite 500, Oak Brook, IL 60523

**Skokie Ambulatory Care Center (SK)**

9650 Gross Point Road, Suite 3000, Skokie, IL 60076

**Skokie Eye and Vision Center (SKE)**

9650 Gross Point Road, Suite 1900, Skokie, IL 60076

**To learn about supporting excellence in clinical care and research at NorthShore Neurological Institute,** please contact John H. Hanson, PhD, Director of Philanthropy at NorthShore University HealthSystem Foundation, at (224) 364-7208 or [jhanson@northshore.org](mailto:jhanson@northshore.org). You can also support NorthShore Neurological Institute by making an online donation at [northshore.org/donate](http://northshore.org/donate) and by selecting NorthShore Neurological Institute from the drop-down menu.

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## Neurological Institute

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Evanston, Illinois 60201

[northshore.org/neuro](http://northshore.org/neuro)

NorthShore Neurological Institute offers patients and their families superior access, proven expertise, advanced technology and outstanding care coordination to treat a variety of neurological diseases and conditions.

NorthShore's multidisciplinary team of neurospecialists—neurologists, neurosurgeons, physiatrists and others—provide personalized, patient-centered care that uniquely draws upon the strength of our extensive experience and collaborative environment.

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