MAYO CLINIC

Neurosciences Update

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Chiari Malformation and Syringomyelia: Investigating the Natural History and Predicting Outcomes

INSIDE THIS ISSUE

If a child has a Chiari malformation (CM) and is asymptomatic, will symptoms develop later, and if so, over what time period? Are there imaging characteristics that can predict symptom onset and surgical outcomes? What is the time course for recovery following surgery for syringomyelia? Do symptomatic patients have other brainstem abnormalities? Nicholas M. Wetjen, MD, a pediatric neurosurgeon at Mayo Clinic in Minnesota, reels off these and other unanswered questions as he explains the need for better understanding of the pathogenesis, natural history, and clinical models of CM and syringomyelia.

CM is a congenital disorder in which the cerebellar tonsils protrude through the foramen magnum into the spinal cord. The disorder may reflect inadequate room in the posterior fossa to contain its structures. CM type I (CM-I) can occur in children and adults and may or may not be symptomatic. CM type II (CM-II) occurs only in patients with spina bifida defects.

The leading cause of syringomyelia, CM also can occur without a syringomyelic cavity. In syringomyelia, a syrinx or cyst accumulates cerebrospinal fluid within the spinal cord, causing expansion of the spinal cord (Figure 1). The symptoms of syringomyelia tend to be more severe than those of CM-I (see Table for common symptoms).

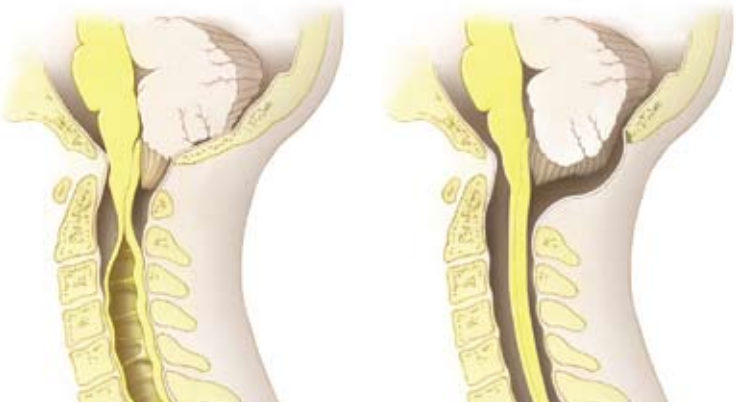


Figure 1. *Left, Illustration of Chiari malformation and syringomyelia (accumulation of fluid within the spinal cord). Right, Illustration of postsurgical correction, in which the first cervical vertebra was removed during suboccipital craniotomy to expand the space available for the cerebellum and allow for increased cerebrospinal fluid circulation.*

As Dr Wetjen notes, MRI has revolutionized CM diagnosis, leading to the detection of previously unrecognized or misdiagnosed occurrences of CM-I. It is present in as many as 2% of the general population, although only a small proportion of those with CM-I are symptomatic. Dr Wetjen sees approximately 180 cases of CM a year, in patients ranging from newborn to 18 years of age, of whom approximately one-third are treated surgically.

The success of surgical reconstruction (Figure 2) depends in large measure on early detection. Diagnosis of CM at Mayo Clinic is conducted by a multidisciplinary team that may include specialists in neurology, otolaryngology, orthopedics, sleep disorders, and speech pathology. "For example," Dr Wetjen says, "a swallow study can detect problems that children are too young to explain and that may have gone undetected by parents." Specialists in sports medicine may also be called on to evaluate the risks of specific athletic activities.

Identification through MRI, patient registry, and review of Mayo's large practice in CM and syringomyelia is providing new opportunities to trace the natural history of these disorders and to predict symptom onset and recovery from surgical intervention. "There are numerous reports in the literature about diagnosis and symptom relief from surgery, but we hope to add specificity," says Dr Wetjen, explaining the series of retrospective and prospective studies that he and his colleagues are conducting. Their investigations are aimed at increased precision

Nicholas M. Wetjen, MD

Table. The Most Common Symptoms Associated With Chiari Malformation and Syringomyelia

Chiari malformation

- Headache often precipitated by Valsalva maneuvers
- Nystagmus
- Vocal quality changes
- Swallowing problems
- Sleep disturbance
- Balance problems and dizziness

Syringomyelia

- Sensory loss or exaggerated response to pain, temperature, or position
- Limb weakness and atrophy (particularly hands and arms)
- Spasticity
- Pain in thoracic spine area and shoulder joints; burning pain in arms and trunk
- Scoliosis
- Sphincter problems
- Autonomic symptoms

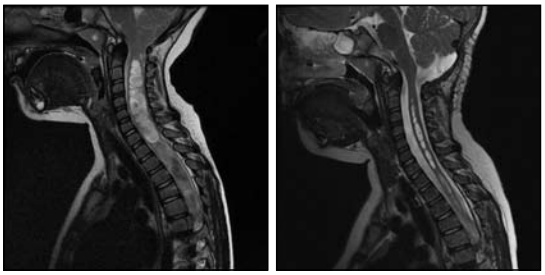


Figure 2. *Left panel, Preoperative sagittal T2 cervical spine MRI showing Chiari malformation and syringomyelia with expansion of the spinal cord. Right panel, Postoperative MRI showing surgical changes of suboccipital craniectomy, C1 laminectomy with duroplasty resulting in enlargement of the space around the cerebellar tonsils, and reduction in the syringomyelia.*

about the course of symptom resolution after surgery, identification of factors that predict both positive and negative outcomes, and a better understanding of brain abnormalities that may be associated with or independent of CM. In addition, Mayo Clinic participates in the Park-Reeves Syringomyelia Research Consortium, a multi-institutional registry that involves more than 30 centers. Through these in-house and collaborative research initiatives, Dr Wetjen and colleagues hope to provide clinical models of practice that can be replicated at other institutions and improve patient care.

Frontiers of Neuroscience: Molecular Discoveries in CNS Protection and Repair

Moses Rodriguez, MD

"Paradoxical findings are often best—better, in fact, than when things turn out the way you expect." So says Moses Rodriguez, MD, a Mayo Clinic Distinguished Investigator and professor of neurology and immunology in Rochester, Minnesota. Three discoveries in central nervous system (CNS) repair and protection at Mayo Clinic highlight the truth of his statement. Each of the discoveries was made during investigations of Theiler's virus, considered one of the premier animal models of multiple sclerosis (MS). Theiler's virus induces encephalomyelitis with chronic inflammation and demyelination and secondary axonal dysfunction in laboratory mice. It is a member of the picornaviruses, viruses for which there are no treatments and that in humans cause a range of conditions from the common cold to poliomyelitis and, possibly, amyotrophic lateral sclerosis (ALS).

Remylination in the CNS: Human Autoantibody 22

In the late 1980s, Dr Rodriguez and colleagues Larry R. Pease, PhD, chair of Mayo's Department of Immunology, and Arthur E. Warrington, PhD, in the Department of Neurology, were testing the theory that stimulating the immune system through immunizations with myelin would aggravate Theiler's virus–induced demyelination, which is similar to human MS.

Surprisingly, during their experiment, they found that rather than showing increased demyelination, the Theiler's virus–infected mice showed evidence of extensive remyelination. It was the first demonstration of naturally induced CNS repair. Their findings led to the now-

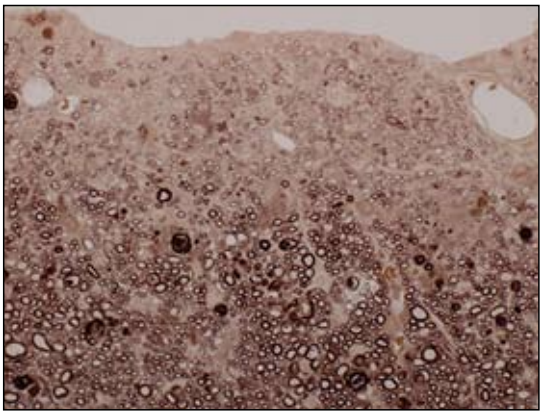


Figure 1. *rHIgM22, a recombinant form of the human immunoglobulin molecule HIgM22, promotes new myelin in the spinal cord. A light micrograph stained for myelin shows remyelination in the spinal cord of a mouse with virus-mediated demyelination. Repair is promoted by a single peripheral dose of rHIgM22, which binds to myelin and oligodendrocytes. Remyelination, characterized by thin myelin sheaths in relation to axon diameter, is present out to the edge of a ventral lateral lesion.*

accepted concept that the inflammatory process which induces demyelination in MS also induces some aspect of remyelination.

Equally surprising was the finding that the repair process they had witnessed was not caused by alterations in the immune response, but rather by molecular actions directed by natural antibodies against the surface of oligodendrocytes themselves, stimulating them to produce myelin. The agents of the observed remyelination were monoclonal autoantibodies (mAbs), which, rather than serving pathologic functions like conventional antibodies, serve normal cell processes.

Over the next several years, the team was able to isolate a human autoantibody, which they labeled *monoclonal HIgM22*. Unlike industry-synthesized antibodies, HIgM22 is a naturally occurring immunoglobulin molecule that is primitive in evolutionary terms and is the body's first and most rapid response, often referred to as the *innate immune response*.

HIgM22 was sequenced into a recombinant form (rHIgM22) in Dr Pease's laboratory and was found to be as effective as its serum-derived counterpart in inducing remyelination in Theiler's virus–infected mice. The results showed that 60% to 80% of the animals' lesions were repaired (Figure 1).

Having manufactured enough rHIgM22 in conjunction with the University of Minnesota to take the drug to clinical trial, the team is now completing the animal toxicity testing required by the FDA and have found no adverse effects. The researchers are writing an Investigational New Drug application for FDA approval to test rHIgM22 as a remyelination treatment for MS, a step required before a novel therapy can go to human clinical trials. rHIgM22 represents a completely unique approach to MS treatment in particular and to restorative CNS therapy in general.

Inhibiting Apoptosis and Stimulating Axonal Outgrowth: Autoantibody 12

In their search for other reparative autoantibodies, Dr Rodriguez and the research team identified two new human mAbs that they named *HIgM12* and *HIgM42*. Both of these molecules promoted in vitro CNS axonal extension and were able to rescue cultured neurons from laboratory-induced apoptosis. Similar to the mechanisms of HIgM22, HIgM12 appears to activate repair and prevent cell death through alterations in molecular signaling, not alterations in the immune system. Dr Rodriguez describes the effects of HIgM12, stating, "When you place the autoantibody on the cell, you can actually see the axon growing" (Figure 2).

HIgM12 has implications for possibly inhibiting apoptosis in stroke, spinal cord injury, primary motor peripheral neuropathies, ALS, Alzheimer's disease, and other diseases that effect cell death and axonal destruction. Again in collaboration with the University of Minnesota, the Mayo Clinic team has successfully manufactured enough of the recombinant form of HIgM12 in pharmacological grade to test it in transgenic mice carrying the gene for one of

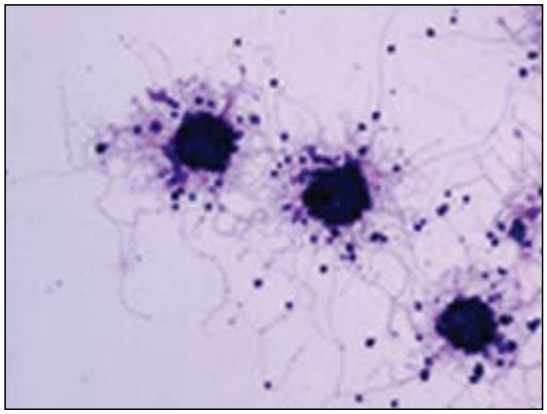


Figure 2. *Neurite outgrowth from cerebellar neurons is driven by a surface of neurons that bind recombinant human antibody rHIgM12. Clusters of mouse cerebellar granule neurons were plated onto a surface coated with rHIgM12. Within 48 hours, extensive process growth is present. Cells were stained with a violet dye to reveal fine structures of neurite growth.*

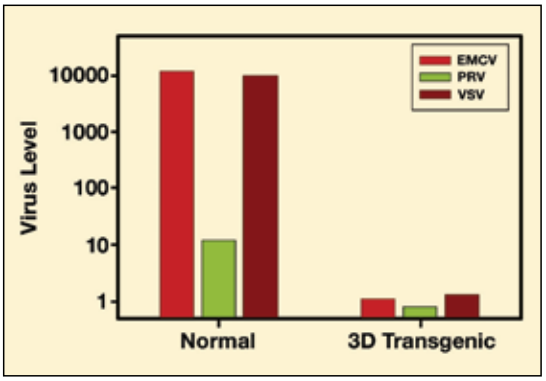


Figure 3. *Expression of the 3D polymerase gene,* $3D^{pol}$*, in mice reduces viral load after infection. Viral load in the spinal cords of* $3D^{pol}$ *transgenic mice and normal mice three days after being infected with one of three different viruses: encephalomyocarditis virus (EMCV), pseudorabies virus (PRV), or vesicular stomatitis virus (VSV). The transgenic mice have substantially less of the three viruses than normal mice.*

the genetic forms of ALS. Animal tests are being conducted in Dr Rodriguez's laboratory.

Inhibiting Viral Replication: The *3D^{pol}* Gene

The *3D^{pol}* gene, or *3D polymerase*, is an RNA-dependent enzyme that has a central role in the replication and transcription of viral RNA. To better understand immune system viral resistance, Dr Rodriguez and his colleagues infected groups of genetically altered mice with genetically manipulated segments of Theiler's virus. Their control group was a group of transgenic mice altered to express the virus-replicating *3D^{pol}* gene and thus would be expected to be highly susceptible to the disease. Instead, they found that the *3D^{pol}* transgenic mice were actually able to resist the virus. It appeared that the endogenously expressed *3D^{pol}* gene was dramatically inhibiting viral replication. The mice had a 100- to 1,000-fold reduction in viral resistance compared with mice that were not expressing the *3D^{pol}* gene (Figure 3).

The researchers then infected *3D^{pol}* transgenic mice with different types of viruses and again found that the viruses did not replicate. As Dr Rodriguez notes, "We have discovered something very fundamental about how viruses replicate, and if we can understand exactly how the *3D^{pol}* gene works against viral replication, we may be on the path to a broadly effective antiviral therapy."

Taken individually or together, these findings may change the approach to treatment of progressive neurologic disease. As Dr Rodriguez puts it, "The scientist wants to discover something that no one has seen before, so I look for experiments that are not working as expected, to try to find out why that is the case." As with many scientific breakthroughs in the past, tracing the origins of counterintuitive results has opened the way to rethinking previously held constructs.

Neurostimulation Across Mayo Clinic's Three Sites

Ryan J. Uitti, MD, and Robert E. Wharen Jr, MD

Mayo Clinic's neurostimulation practice was pioneered and refined in the mid-1990s by neurosurgeon Robert E. Wharen Jr, MD, and neurologist Ryan J. Uitti, MD, at Mayo Clinic in Florida as part of the clinical trials that led to FDA approval of deep brain stimulation (DBS). It has since become one of the largest neurostimulation practices in the world. Across Mayo's three campuses, interdisciplinary teams carefully screen patients, provide treatment for common and uncommon neurologic conditions, and follow up with expert stimulator programming. They collaborate on research and practice standards. Their success rests on experience, expertise, and rigorous patient selection criteria.

The directors of Mayo's neurostimulation program, which includes DBS and motor cortex stimulation, are neurosurgeon Mark K. Lyons, MD, and neurologist Virgilio Gerald H. Evidente, MD, in Arizona; Drs Wharen and Uitti in Florida; and neurosurgeon Kendall H. Lee, MD, PhD, neurologist Bryan T. Klassen, MD, and pediatric neurologist Matt Stead, MD, PhD, in Minnesota. Dr Klassen joined the DBS staff at Mayo Clinic in Minnesota this year, after a neurology residency, DBS fellowship, and specialized training in movement disorders.

Dr Lyons has conducted a review of trends and future applications of DBS in *Mayo Clinic Proceedings* (2011;86[7]:662-72). On the basis of careful analysis of outcomes reported in the medical literature and internal research, Mayo Clinic has expanded its practice to include the diseases and conditions listed in the Table. Herein are a few highlights of the current DBS experience across Mayo Clinic.

Parkinson's Disease and Tremor

DBS has largely replaced ablative surgery (stereotactic thalamotomy) for advanced cases of tremor in levodopa-responsive Parkinson's disease (PD) and medically refractory essential tremor (ET). Typically, the treatment target is either the subtha-

lamic nucleus (STN) or the globus pallidus in PD and the thalamus in tremor disorders. In addition to improving tremor, DBS surgery for patients with PD also has been found to improve gait disturbance, rigidity, and symptoms of bradykinesia and to reduce dyskinesias caused by long-term levodopa therapy.

In a recent retrospective study, Joseph Matsumoto, MD, and colleagues across Mayo Clinic used a PD rating scale to determine differences in the pattern of responses to levodopa and DBS targeting the STN (STN-DBS) in a series of 60 patients. The investigators found that the combination of levodopa and STN-DBS is superior to either DBS or levodopa therapy alone.

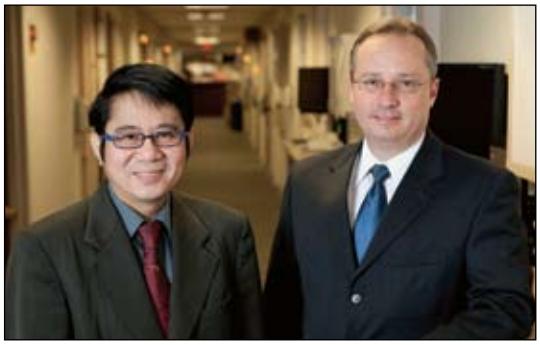
In the *Archives of Neurology* (2011;68[8]:1033-6), Dr Klassen and colleagues report on the efficacy of DBS in a case series of tremor associated with benign tremulous parkinsonism (BTP), a condition within the spectrum of parkinsonism. BTP may appear similar to early PD, although as the two diseases progress, their symptoms diverge. Gait is not disturbed in BTP, and tremor is usually severe and unresponsive to levodopa.

Rare types of tremor treated with DBS at Mayo include orthostatic tremor, a variant of ET that affects the lower limbs on standing and spreads up the trunk. Treated at Mayo Clinic in Arizona, a patient with orthostatic tumor showed 60% improvement in lower limb tremor. Drs Lyons and Evidente have also reported successful DBS surgery for a case of primary writing tremor and a case of genetically confirmed fragile X tremor ataxia syndrome.

Restless Legs Syndrome and Abnormal Movement During Sleep

Restless legs syndrome (RLS) can affect up to 25% of adults, and its prevalence often is increased in patients with PD or ET. Mayo Clinic does not offer DBS for cases of isolated or primary RLS, but patients with PD who are undergoing DBS surgery at Mayo are given presurgical and postsurgical testing for RLS. Recently, Drs Evidente, Klassen, and Lyons reported on a patient in whom severe periodic limb movements during wakefulness were reduced following DBS for PD. The Arizona team also has reported on six patients with PD whose average RLS scores dropped by 84% following DBS surgery (*Mov Disord.* 2006;21(8):1287-9).

In a series of patients with RLS who have ET or dystonia without PD, Dr Evidente has observed that RLS relief ranges from 25% to 100% with DBS (unpublished data). Periodic limb movements during sleep were also noted to improve in a patient who underwent bilateral thalamic DBS for severe ET. The Arizona team conducted a sleep study before and after DBS surgery and also studied the patient's response with and without stimulation during DBS surgery. They found that DBS markedly decreased the patient's limb movements.



Virgilio Gerald H. Evidente, MD, and Mark K. Lyons, MD

Kendall H. Lee, MD, PhD, and Bryan T. Klassen, MD

Dystonia

Neurologists and neurosurgeons across Mayo Clinic agree that symptom improvement with DBS for dystonia is more limited than it is for tremor. Drs Evidente and Lyons reported on the first DBS surgery for X-linked dystonia parkinsonism, or Lubag, a progressive dystonia that occurs in one of every 4,000 men of southern Filipino extraction. They are monitoring the results of DBS on more patients with Lubag, all of whom have had some measure of symptom relief.

Recently, Drs Evidente and Lyons conducted DBS for a patient with dopa-responsive dystonia. As its name implies, this type of dystonia is responsive to levodopa, although some patients may not tolerate the adverse effects of or eventually may no longer benefit from levodopa therapy. Before undergoing DBS, the patient was taking levodopa every few hours, with considerable adverse effects. After DBS, the patient's need for levodopa and the adverse effects it caused were markedly diminished.

Meige syndrome is an idiopathic segmental dystonia characterized by blepharospasm and craniofacial dystonia. Although the syndrome is initially responsive to botulinum toxin injections, many patients eventually have a poor response to treatment. Reporting on one of the largest case series to date of DBS for Meige syndrome, Drs Lyons and Evidente and colleagues found that DBS was effective (*Neurosurg Focus*. 2010;29[2]:E5. DOI: 10.3171/2010.4.FOCUS1067). More recently, a patient with Meige syndrome also had marked oropharyngeal dystonia with compromised respiration and sleep that improved with DBS surgery.

Ataxia: Cautionary Notes

Dr Uitti notes that although DBS can be successful

in treating tremor, it has little effect on the ataxia that can accompany tremor in certain conditions. In addition, limb, gait, and speech ataxia can result from aggressive neurostimulation in patients with ET who undergo thalamic DBS.

In particular, ataxia can be severe in patients with Hashimoto's disease, a progressive thyroiditis. At the 2011 American Academy of Neurology meeting, the team at Mayo Clinic in Arizona presented a case of a patient with a history of hypothyroidism and ET. The patient regained control of severe bilateral hand tremor following DBS surgery, but when seen at Mayo Clinic three years later, the patient had developed cerebellar gait and limb ataxia, which did not improve upon withdrawal of neurostimulation. The investigators speculated that the ataxia may have been due to "an additive or synergistic effect" between bilateral thalamic DBS and Hashimoto's disease. They suggested that before undergoing thalamic DBS surgery, patients should be screened for thyroid dysfunction and Hashimoto's disease.

Table. Disorders and Diseases for Which Mayo Clinic Offers Neurostimulation

Parkinson's disease
Essential tremor
Centrally mediated neuropathic pain
Cluster headache
Poststroke pain
Trigeminal neuralgia
Choreas
Dystonias
Pediatric epilepsy
Tourette syndrome

Neuropathic Pain

Motor cortex stimulation has been used across the three sites to treat facial pain, such as anesthesia dolorosa. As Dr Uitti points out, outcomes are best when the facial area targeted is relatively small. Pain specialists and psychiatrists participate in the evaluation of patients seeking neurostimulation for pain. Dr Klassen and colleagues have found that in patients treated with motor cortex stimulation, subdural electrode placement may be superior to epidural placement.

Over the past two years, Drs Uitti and Wharen have conducted DBS surgery in patients with cluster headache, a condition caused by activity in the hypothalamus. Dr Uitti notes that the stabbing pain can be so severe that some patients contemplate suicide, so he is particularly pleased to report that most of his patients continue to be headache free several years after DBS surgery. Dr Wharen explains that for these cases, pretesting helps in patient selection. Headaches can be induced through the application of histamines and the activity of the hypothalamus monitored during a presurgical PET procedure. During DBS surgery, the headache can again be induced to see whether electrode placement in the hypothalamus aborts the symptoms.

Pediatric Epilepsy

Mayo Clinic in Minnesota is one of the few institutions in the world to offer DBS for intractable epilepsy in children. For example, Mayo Clinic specialists operated on a three-year-old child with Lennox-Gastaut syndrome, one of the youngest patients ever to undergo DBS. The surgery resulted in marked seizure reduction.

Tourette Syndrome

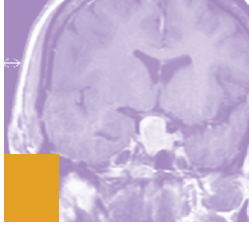
The symptoms of Tourette syndrome tend to improve after adolescence, and medication is effective in many cases. DBS surgery is one option for carefully selected patients with medically refractory Tourette syndrome. Drs Lee, Stead, and Klassen have conducted DBS surgery in four patients with Tourette syndrome, two of whom were adolescents who had symptoms so severe that the tics caused them physical harm. After treatment, the number of tics was markedly reduced in all four patients.

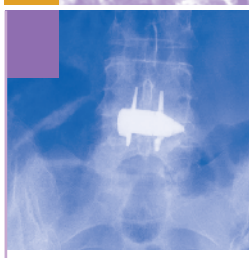
Research Update

For the past three years, the DBS teams at Mayo Clinic in Florida and Mayo Clinic in Minnesota have been participating in a clinical trial to test a new stimulator device. The Florida team is the number one recruiter for the study in the nation.

Mayo Clinic continues to be a leader in DBS basic science research, with Dr Lee serving as director of Mayo's Neural Engineering Laboratory and lead investigator of a Mayo-based, National Institutes of Health–funded, multiinstitutional investigation into the mechanisms of DBS. Having designed the Wireless Instantaneous Neurotransmitter Concentration Sensing System (WINCS), Dr Lee and his colleagues are conducting real-time tests of changes in neural and neurochemical activity in DBS.

Research Highlights





New Genetic Cause of Neurodegeneration Found

Using next-generation genomic sequencing technology, Mayo Clinic researchers have discovered two mutations responsible for a devastating neurological condition they first identified 15 years ago. Called *hereditary sensory and autonomic neuropathy type 1 (HSAN1) with dementia and hearing loss*, symptoms begin to appear at 20 to 35 years of age, after which distal sensory loss and a slow deterioration in cognitive ability and hearing develop. Although there is no treatment for HSAN1, the identified mutations in DNA methyltransferase 1 help to elucidate the mechanisms of HSAN1 and similar neurodegenerative conditions. The study was published in *Nature Genetics* (2011;43[2]:595-600). Authors: C. Klein, M. Botuyan, Y. Wu, C. Ward, G. Nicholson, S. Hammans, K. Hojo, H. Yamanishi, A. Karpf, D. Wallace, M. Simon, C. Lander, L. Boardman, J. Cunningham, G. Smith, W. Litchy, B. Boes, E. Atkinson, S. Middha, P. J. B. Dyck, J. Parisi, G. Mer, D. Smith, and P. J. Dyck.

Mild Cognitive Impairment

Ronald C. Petersen, MD, PhD, a Mayo Clinic neurologist and director of the Mayo Clinic Alzheimer's Disease Research Center, reviewed the diagnosis of mild cognitive impairment (MCI), its implications for the subsequent development of dementia, and potential management strategies in the *New England Journal of Medicine* (2011;364[23]:2227-34). The article discusses the possible use of imaging and biomarkers to identify persons at high risk. MCI has received considerable attention in clinical practice and research settings. The Alzheimer's Association updated the guidelines defining Alzheimer's disease and MCI, adding an additional predementia phase called *preclinical Alzheimer's disease.*

Mayo Clinic Offers Less Invasive Treatment for Large Cerebral Aneurysms

Flow diversion is a new philosophical approach to the treatment of intracranial aneurysms. The FDA has approved use of the pipeline embolization device, a new therapeutic approach for patients with large, giant, and wide-necked cerebral aneurysms. Mayo Clinic neurosurgeon Guiseppe Lanzino, MD, took part in a research study on the new device, and Mayo Clinic is one of two centers in the United States using the technology. Surgical and endovascular therapies, widely used to treat cerebral aneurysms, can be risky for large aneurysms and may damage surrounding blood vessels. The new approach is less invasive and more effective in preventing rupture.

Cerebrovascular Risk Factors and Preclinical Memory Decline in Healthy APOE ϵ4 Homozygotes

People who have cardiovascular risks and carry the *APOE ϵ4* gene associated with Alzheimer's disease may experience age-related memory decline 20 to 25 years earlier than people who carry the gene and have no cardiovascular risks, according to a 17-year, Mayo Clinic–led study recently published in *Neurology* (2011;76[12]:1078-84). The researchers performed longitudinal neuropsychological testing, with the long-term memory score of the Auditory Verbal Learning Test as the primary outcome measure in *APOE ϵ4* carriers aged 21 to 97 years. In exploratory analyses, significant deleterious effects were detected for prior cigarette use, diabetes mellitus, and hypertension. After correction for multiple comparisons, the statistical significance remained for prior cigarette use only. The researchers concluded that cardiovascular risk factors influence age-related memory decline in *APOE ϵ4* homozygotes. Authors: R. Caselli, A. Dueck, D. Locke, M. Sabbagh, G. Ahern, S. Rapcsak, L. Baxter, R. Yaari, B. Woodruff, C. Hoffman-Snyder, R. Rademakers, S. Findley, and E. Reiman.

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Research Highlights

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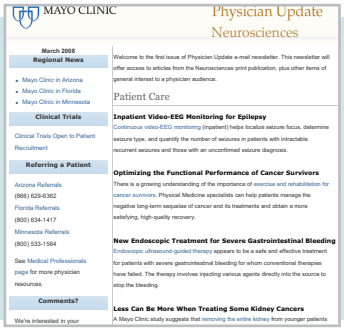
Paraneoplastic Isolated Myelopathy

Mayo Clinic researchers systematically reviewed the clinical, serologic, and MRI data of 31 patients who presented with an isolated myelopathy and either coexisting cancer (ie, carcinoma, melanoma, or other cancer) or a paraneoplastic autoantibody with a strong cancer association. The researchers concluded that symmetrical, longitudinally extensive, tract or gray matter–specific changes seen on spinal MRI should raise suspicion for a paraneoplastic myelopathy. Resulting disability is often severe, and only a minority of the patients improve with treatment (*Neurology*. 2011;76[24]:2089-95). Authors: E. Flanagan, A. McKeon, V. Lennon, J. Kearns, B. Weinshenker, K. Krecke, M. Matiello, B. Keegan, B. Mokri, A. Aksamit, and S. Pittock.

CME

Please join the Mayo Clinic Neurology and Neurosurgery Continuing Medical Education (CME) Facebook group. To join, search Facebook for Mayo Clinic Neurology and Neurosurgery Continuing Medical Education (CME). This group will provide CME course information and updates along with short video interviews with speakers and course directors.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Welcome to the first issue of Physician Update e-mail newsletter. This newsletter will offer access to articles from the Neurosciences print publication, plus other items of general interest to a physician audience.

Patient Care

Inpatient Video-EEG Monitoring for Epilepsy

Continuous video-EEG monitoring (inpatient) helps localize seizure focus, determine seizure type, and quantify the number of seizures in patients with intractable recurrent seizures and those with an unconfirmed seizure diagnosis.

Optimizing the Functional Performance of Cancer Survivors

There is a growing understanding of the importance of exercise and rehabilitation for cancer survivors. Physical Medicine specialists can help patients manage the negative long-term sequelae of cancer and its treatments and obtain a more satisfying, high-quality recovery.

New Endoscopic Treatment for Severe Gastrointestinal Bleeding

Endoscopic ultrasound-guided therapy appears to be a safe and effective treatment for patients with severe gastrointestinal bleeding for whom conventional therapies have failed. The therapy involves injecting various agents directly into the source to stop the bleeding.

Less Can Be More When Treating Some Kidney Cancers

A Mayo Clinic study suggests that removing the entire kidney from younger patients

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Expedited Patient Referrals to Mayo Clinic Departments of Neurology and Neurologic Surgery

While Mayo Clinic welcomes appointment requests for all neurologic and neurosurgical conditions, patients with the following conditions are offered expedited appointments:

1. Cerebral aneurysms
2. Cerebral or spinal arteriovenous malformations
3. Brain, spinal cord, or peripheral nerve tumors
4. Epilepsy with indications for surgery
5. Carotid disease

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