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Management Options for Primary Hyperhidrosis

Primary hyperhidrosis, or excessive sweating, affects not only the health of the skin but also emotional, physical, and social well-being. Dripping wet hands or feet can restrict career choice and the ability to participate in activities that involve tools or instruments—from work to music to sports. It can create a fear of intimacy, low self-esteem, and social isolation. A Mayo Clinic-funded study recently found that 50% of those with hyperhidrosis suffer from social anxiety.



Robert D. Fealey, MD

Robert D. Fealey, MD, a neurologist at Mayo Clinic in Rochester, Minnesota, has treated patients with hyperhidrosis for more than 25 years. He notes that psychological distress often reverses with successful management of the symptoms. Although hyperhidrosis has only recently been recognized as a serious medical condition, the departments of dermatology, neurology, and neurosurgery at Mayo Clinic have a long history of working together to treat primary hyperhidrosis. Management includes surgical and nonsurgical options as well as objective measures of severity and anatomic distribution and, for severe cases, an improved surgical approach not found at other institutions.

Primary vs Secondary Hyperhidrosis

Excessive sweating in primary or essential hyperhidrosis is thought to originate in the anterior cingulate cortex in response to emotional stimuli and is not considered a malfunction of the thermoregulatory system. It occurs independent of other conditions.

Primary hyperhidrosis has a prevalence of 2.8% in the United States. It is estimated that as many as half of those affected are unaware that treatments exist and do not seek medical help. Primary hyperhidrosis is usually focal, affecting the eccrine sweat glands of the axillae, palms of the hands, soles of the feet, and, more rarely, the face. The condition usually begins in childhood or adolescence. It is

often inherited; approximately one-third of patients report a family history.

Secondary hyperhidrosis is associated with disorders such as chronic infection, malignancy, neurologic and endocrine disorders, and spinal cord injury. Patients with secondary hyperhidrosis often experience “night sweats,” whereas patients with primary hyperhidrosis sweat excessively only when awake.

Diagnosis

After the history and physical examination, various laboratory tests can confirm the diagnosis and document the anatomic site where sweating



Figure 1. A, Primary, focal palmar hyperhidrosis demonstrated via purple staining with alizarin. B, Ventilated capsule recording from a patient with severe palmar hyperhidrosis. The symmetric, pulsatile, emotionally driven, and localized sweating of the palms (red and green curves) and not of the nearby forearm (blue curve) is well shown.

Reprinted with permission from Fealey RD, Sato K. Disorders of the eccrine sweat glands and sweating. In: Wolff K, Goldsmith LA, Katz SI, Gilchrist BA, Leffell DJ, eds. Fitzpatrick's Dermatology in General Medicine, 7th ed. New York, NY: McGraw-Hill, 2007; p 721, 723.

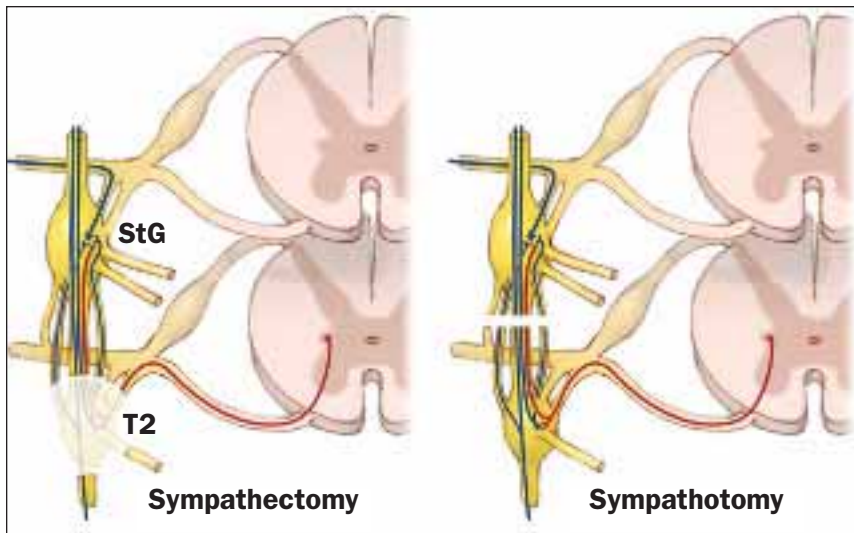


Figure 2. Schematic drawing of sympathectomy vs sympathotomy. Sympathectomy, with use of ganglionectomy and by definition, must sever the primary axon from the neuron in the intermediolateral cell column of the spinal cord (red) before primary or collateral synapse in the T2 ganglion. This injures all the neurons at this level of the spinal cord, some of which may die, and may predispose the patient to spinal cord reorganization and severe compensatory hyperhidrosis. Sympathotomy interrupts only axons after potential T2 ganglion synapses, a less injurious effect on the neuron, and is the least destructive procedure possible with successful treatment of palmar hyperhidrosis. StG, stellate ganglion.

Reprinted with permission from Atkinson JLD, Fealey RD. Sympathotomy instead of sympathectomy for palmar hyperhidrosis: minimizing postoperative compensatory hyperhidrosis. *Mayo Clin Proc* 2003;78:167-172.

occurs. Among these is the Mayo Clinic thermoregulatory sweat test. A mixture of starch, alizarin red, and sodium carbonate is painted on the anterior body surface and the palms and feet. The mixture turns from yellow-orange to dark purple in response to sweat (Figure 1A). Computer-generated pictures are obtained under normal and elevated temperatures. This test helps to document the severity as well as the symmetric distribution of the sweating, another feature of primary hyperhidrosis.

Measuring severity is a critical step in determining the best treatment options. Severe cases, for example, may warrant surgery. There are several subjective rating scales that measure the degree to which hyperhidrosis interferes with daily life. For more objective data, Dr Fealey designed a humidity detector in which probes on the skin record sweat output relative to changes in humidity at normal temperatures. Changes from baseline measures are recorded as the patient is put under gentle stress (eg, computing serial 7s). As he explains, sweat driven by the anterior cingulate is not produced in a steady flow, but rather comes in waves or pulses. The waveform recordings are used to determine severity as well as to monitor treatment

outcomes (Figure 1B).

Nonsurgical Management

Treatment typically begins with topical agents that block the sweat ducts. These include over-the-counter and prescription antiperspirants applied to dry skin at night and washed off 6 to 8 hours later. Anticholinergics are another option. They inhibit acetylcholine activity on sweat glands innervated by postganglionic nerves and can be applied topically or taken by mouth. Adverse effects may include dry mouth and eyes, blurred vision, and difficulty with urination.

Iontophoresis is often tried when topical agents fail. A battery-powered device drives a low-level electrical current through water-saturated wool pads to the affected areas. This technique alters the outer layers of the skin to prevent sweat from coming to the surface. Hands and feet are treated separately. Each site must be treated twice a day for up to 30 minutes for approximately 2 weeks. Treatment effects may last for several weeks but may not be more effective than antiperspirants.

Over the past 10 years, botulinum toxin (Botox), which blocks nerve endings from releasing acetylcholine, has been used. Dr Fealey states that, in his experience, the greatest value of botulinum toxin is in treating the axillae, but it can be injected into the hands and feet as well. Injections done with the patient under local anesthesia are repeated every 4 to 6 months. Botulinum toxin can be applied to the face (around the hairline) in low doses, but there is a risk of weakening the facial muscles. At Mayo Clinic, this type of botulinum toxin injection is administered by dermatologists.

Sympathotomy

Neurosurgery is an option reserved for intractable palmar hyperhidrosis. The approach used throughout the United States is a sympathectomy. Available for more than 70 years, it involves removing most or all of the upper thoracic sympathetic chain. The second thoracic ganglion, the largest relay center of sympathetic neurons to the upper extremities, is always removed in sympathectomy. Endoscopic techniques make it a minimally invasive procedure.

Unfortunately, a common complication of sympathectomy, affecting 5% to 20% of patients, is excessive compensatory sweating in the trunk, groin, legs, or all these sites. In describing extreme cases of compensatory hyperhidrosis, John L. D. Atkinson, MD, a Mayo Clinic neurosurgeon, notes that patients may no longer need to use handkerchiefs 40 times a day to wipe their hands but instead

Hyperhidrosis Specialists

NEUROLOGY

Florida
William P. Cheshire, Jr, MD
Minnesota
Robert D. Fealey, MD

NEUROSURGERY

Florida
Robert E. Wharen, Jr, MD
Minnesota
John L. D. Atkinson, MD



Figure 3. A young, healthy patient with primary palmar-plantar hyperhidrosis in resting conditions at room temperature. A, The mixture of starch, alizarin red, and sodium carbonate is placed on the anterior body surface, including the palms, and the resting palmar sweating changes the indicator color from light orange to purple. B, Test is repeated in the same patient under the same conditions 2 months after successful endoscopic thoracic sympathectomy, and no resting palmar sweat is visible.

Reprinted with permission from Eisenach JH, Atkinson JLD, Fealey RD. Hyperhidrosis: evolving therapies for a well-established phenomenon. *Mayo Clin Proc* 2005;80:657-666.

need to change their slacks 6 times a day because of excess sweating in the groin and legs.

To overcome compensatory hyperhidrosis, Dr Atkinson pioneered a procedure, unique to Mayo, called an endoscopic transthoracic sympathectomy

(Figure 2). The sympathetic chain leading to the brachial plexus is not entirely removed. Instead, the second thoracic ganglion is disconnected from the stellate ganglion. In a prospective study of 10 patients undergoing sympathectomy, Drs Atkinson and Fealey found the procedure effective in controlling hyperhidrosis without causing compensatory sweating (Figure 3). Dr Atkinson has now performed sympathectomies on more than 120 patients. None has had severe compensatory hyperhidrosis in normal, temperature-controlled environments. A few have had truncal hyperhidrosis in hot temperatures or with vigorous exercise. In an ongoing investigation of a phenomenon never before studied, he and his colleagues have found that the procedure does not appear to affect sympathetic innervation to the heart to any notable degree. Thus, the results to date suggest that endurance exercise or training is not affected by sympathectomy.

Dr Atkinson cautions that neither sympathectomy nor sympathectomy is a good option for facial hyperhidrosis alone because it may induce Horner syndrome and/or a chimera in which sweating and facial redness occur on only 1 side of the face. It is also not appropriate for plantar hyperhidrosis alone because reducing sympathetic innervation to the lower extremities has consequences for maintaining blood pressure and can cause severe orthostatic hypotension.

Drs Fealey and Atkinson agree that in severe cases, successful sympathectomy in which compensatory hyperhidrosis is avoided can change patients' lives well beyond dry hands.



John L. D. Atkinson, MD



Edward M. Manno, MD

Neurocritical Care: Expanding the Practice at Mayo Clinic

Neurocritical care is a rapidly growing medical subspecialty. Edward M. Manno, MD, a Mayo Clinic neurointensivist, recalls founding the Neurocritical Care Society with a handful of other neurologists. "At our first meeting, 6 years ago, we thought we'd have about 40 people, and about 200 showed up," he says. "Now the society has nearly 1,000 members."

Neurocritical Care at Mayo Clinic in Rochester

Recognizing that managing an acute, life-threatening neurologic crisis requires special skills, Mayo Clinic established one of the nation's first dedicated neurosurgical intensive care units more than 50 years ago. In the early 1990s, the unit became a combined neurologic/neurosurgical intensive care unit with a 20-bed capacity. It is one of a



John L. D. Atkinson, MD

few such units in the country and among the largest.

The advantage for patients is the integrated team care. Dr Manno serves as the neurology codirector, and John L. D. Atkinson, MD, is the neurosurgery codirector. Critical care anesthesiologists are part of the team, providing procedural and

ventilatory support and managing patients who become somatically impaired or who are in systems failure. Interventional radiologists are available to do intracranial stenting and coiling. Nurses and technicians are specially trained to observe subtle changes in neurologic status and manage procedures unique to neurologically impaired patients. As Dr Manno says, "The principles of neurocritical and general critical care certainly overlap, but, for example, patients on a general intensive care unit don't routinely have their pupils checked every hour."

Dr Atkinson adds that the coordination with neurology works well for neurosurgical cases. "Some of the nuances of managing neurosurgical patients are in the realm of medical neurology. And neurosurgeons are present when a neurology patient needs a surgical consult. The patient is a crucible, and everyone the patient needs is around the bedside—a critical care anesthesiologist managing total body failure and 2 neurologic specialties concentrating on the nervous system."

The Rochester unit serves patients with routine as well as rare disorders, including neurovascular disorders, head trauma, encephalopathy, intractable seizures, meningitis, Guillain-Barré syndrome, myasthenia gravis, end-stage amyotrophic lateral sclerosis, and disorders requiring neurosurgery. Recently, the unit cared for 2 patients who are among the longest reported cases of medication-induced coma for recalcitrant seizures. Both patients were in a coma for 2 to 3 months, and both made excellent recoveries. Nonsurgical cases may enter the unit directly or be referred from the clinical practice. Some neuromuscular outpatients, for example, may be transferred to the unit for plasmapheresis therapy.

The unit also serves as referral base for the upper Midwest, available to take calls from emergency department physicians in other locations regarding a potential interventional procedure or the consideration of having a patient flown to Rochester.

Neurocritical Care at Mayo Clinic in Jacksonville

W. David Freeman, MD, trained at Mayo Clinic in Rochester and was asked to start a neurocritical care unit at Mayo Clinic in Jacksonville. Modeled on the Rochester unit, the combined neurology/neurosurgery unit in Jacksonville opened in February 2007 and serves an average of 8 patients and as many as 13 patients at a time. In the new hospital at Mayo Clinic in Jacksonville, which opened in April, the neurocritical care unit is housed within the surgical intensive care unit and is staffed by consultants from neurology, neurosurgery, and anesthesiology. The unit has 24 beds

Neurocritical Care Specialists

NEUROLOGY

Arizona

Bart M. Demaerschalk, MD

Florida

Benjamin H. Eidelman, MD

W. David Freeman, MD

James F. Meschia, MD

Minnesota

Edward M. Manno, MD

Alejandro A. Rabinstein, MD

Eelco F. M. Wijdicks, MD

Neurocritical Care Research Highlights

In the past 10 years Mayo Clinic has

- developed national criteria for defining brain death
- developed predictors of acute neuromuscular respiratory failure in Guillain-Barré syndrome
- developed extubation criteria for acutely ill neurologic patients
- characterized natriuretic factors in aneurysmal subarachnoid hemorrhage
- characterized neurologic complications after transplant
- developed predictors of deterioration in neurologic critical illness
- characterized CT scan abnormalities predicting ischemia-related cerebral swelling

Goals include future investigations of

- the implication of abnormal volume and sodium homeostasis in aneurysmal subarachnoid hemorrhage
- treatment of early swelling in large hemispheric stroke using an invasive cooling device
- early surgical evacuation of lobar hematoma in patients whose condition is deteriorating
- assessing cerebral metabolism using magnetic resonance technology in critical neurologic illness
- pulmonary care in acutely ill neurologic patients



W. David Freeman, MD

and can be expanded to 54 beds.

The unit is staffed by approximately 60 specialty-trained nurses. Thirty more have just completed neurocritical care training. The plan is for all 90 to become certified by the American Association of Neuroscience Nursing.

Mayo Clinic's inpatient practice in Jacksonville is one of only a few in the region in which neurointerventionists conduct intracranial stenting and coiling for aneurysms as well as mechanical clot removal. "Local hospitals with patients who have cerebrovascular crises such as ruptured aneurysms or other critical care issues call us for advice and send patients to us. With the new hospital and neurocritical care unit, we look forward to serving surrounding cities and states in the same way. One of the strengths of our program is its collaborative nature. When we get a call, we call the other members of the team to consult on what is best for the patient," explains Dr Freeman.

Neurocritical Care at Mayo Clinic in Arizona

Although the hospital at Mayo Clinic in Arizona is not a trauma center, neurologists and neurosurgeons provide comprehensive, collaborative intensive management of all other life-threatening nervous system conditions. This year, the hospital earned the American Stroke Association Sustained Gold Performance Achievement award. A member of the stroke team, which includes vascular neurologists and endovascular surgical neuroradiologists, is on call 24 hours a day, 7 days a week and can instantly mobilize other members of the team. The Mayo Clinic hospital in Arizona also serves as a telestroke center for physicians in distant locations. Bart M. Demaerschalk, MD, head of the stroke team, notes that "as the hospital grows from 200 to approximately 500 beds over the next 6 years, increased patient volume will no doubt warrant a specialized neurocritical care unit. For now,



Eelco F. M. Wijdicks, MD

our expertise in interdisciplinary management of acute neurologic crises serves our patients to the best advantage."

Cross-site Collaboration

The neurocritical care unit at Mayo Clinic in Rochester provides leadership to the larger community. Eelco F. M. Wijdicks, MD, who serves as chair of the Division of Critical Care Neurology for Mayo's 3 sites, is a neurointensivist and pioneer in neurocritical care and editor of the journal *Neurocritical Care*. He spends several weeks each year at Mayo Clinic in Arizona working in the hospital and conducting a lecture series attended by intensive care physicians, neurologists, neurosurgeons, residents, and fellows. As Dr Demaerschalk says, "Dr Wijdicks immerses himself in our group and keeps our skills sharp, sharing his time and expertise willingly." Fellows and residents from both the Arizona and Jacksonville sites can also have special training with the Rochester neurointensivist staff. All 3 sites collaborate in research projects on a wide array of topics (see sidebar on page 4).

Multidisciplinary collaboration in managing life-threatening neurologic conditions is the binding factor in neurocritical care within and across all 3 Mayo sites. Reflecting on the program, Dr Manno states, "This kind of collaborative effort is good for both patients and staff." Fifty years of clinical experience and groundbreaking research in Mayo's hospitals continues to advance this important subspecialty.



Bart M. Demaerschalk, MD

Three for One: Neurology Residency Training at Mayo Clinic

Reflecting on his experience as a neurology resident at Mayo Clinic in Rochester in 1919, John B. Doyle, MD, spoke of "the team spirit that fostered the development of individual talents and mutual advancement" and promoted "reciprocal development" of staff and residents. Decades later, that same collaborative, collegial relationship between

staff and trainees is fusing resources and talents across Mayo's 3 sites. Neurology residency training began at Mayo Clinic in Jacksonville in 2002 and at Mayo Clinic in Arizona in 2004.

Regardless of which site they choose, residents have the advantage of a 3-site integrated curriculum, shared resources, state-of-the-art facilities,



Christopher J. Boes, MD

and the option of subspecialty rotations at each of the other sites. Mayo's 3 shields represent not just ideals, but reality. The middle shield stands for patient care, which always comes first and is inextricably linked to education and research, the 2 shields flanking and intertwined with it. "No matter how subspecialized our residents become, they are trained to be exemplary general neurologists, first and foremost. Fortunately, we are big enough, diverse enough, and have the depth of expertise to teach them to be academic leaders and researchers as well as top-notch clinicians," says Christopher J. Boes, MD, director of the neurology residency program in Rochester. "Whether they enter general practice, an academic setting, or focus their career on research or teaching, they will be prepared."

His colleagues, David J. Capobianco, MD, and David W. Dodick, MD, directors of neurology residency training at Mayo Clinic in Jacksonville and Arizona, respectively, share Dr Boes's commitment and enthusiasm. Outside their regularly scheduled meetings, the 3 program leaders connect frequently to track progress and share ideas. "The keys to our success are the 3 Cs—collaboration, cooperation, and communication. We support that mission through our shared curriculum, objectives, tools, experience, and resources. The Mayo culture places high value on education, supporting the patient, the learner, and the educator. It makes our job easy," says Dr Capobianco. Adds Dr Dodick, "Education is a priority, and every faculty member in neurology is committed equally to the program and to the residents."

Curriculum Integration and Innovation

Residents at any of the 3 sites participate in an integrated curriculum that includes courses taught by respected neurologists and teleconferenced to each site. As Robert D. Brown, Jr, MD, current chair of neurology at Mayo Clinic in Rochester and former neurology residency program director explains, "Our didactic program is one of the strongest in the nation because all the staff physicians are intimately involved in the training. Unlike some programs in which senior-level faculty are less visible, ours participate in our education programs across the spectrum of their careers." For example, Eduardo E. Benarroch, MD, a neurologist at Mayo Clinic in Rochester, author of an authoritative neuroscience text, and director of a neuroscience course under the auspices of the American Academy of Neurology, oversees Mayo's neuroscience training at the 3 sites. His neuroscience course is carried by satellite from Rochester to residents in Jacksonville and Arizona.

Evidence-based medicine (EBM) is taught by Bart M. Demaerschalk, MD, and Dean M. Wingerchuk, MD, at Mayo Clinic in Arizona and teleconferenced to Jacksonville and Rochester through the MERIT program (Mayo Clinic Arizona Evidence-Based Clinical Practice, Research, Informatics, and Training Center). Its goal is to foster the life-long critical thinking skills needed to evaluate research findings that impact patient care. A trainee, a faculty member from 1 of the 3 sites with expertise in the topic area, and a MERIT faculty member lead a structured, patient-based, satellite-transmitted presentation that takes participants through all aspects of the EBM process. The peer-reviewed summary is available on Mayo's intranet and is published in the journal *The Neurologist*.

Other innovations include a course designed over the past 5 years by Drs Dodick and Capobianco. It is a core-competency, Web-based educational module known as the American Headache Society Neurology Resident Program. In 2007, its first year, nearly 200 residents from 62 neurology residency programs participated. The case modules allow program directors outside Mayo to compare the performance of their residents with that of others who have completed the training. The program seeks to identify gaps in learning and to provide solutions.

In addition to teleconferenced courses, various senior faculty also spend time at the other sites in both lecture and hands-on training in patient care.

Patient-Centered Clinical Training

Clinical practice is as necessary to residency training as didactics. Every patient is unique, and it is through hands-on experience and supervision that both patient and educational needs are served. Dr Dodick notes that one of the highlights of the Mayo program is the "depth of clinical experience with an excellent mix of routine and esoteric neurologic disorders."

"A good way to measure a program is to check how much time it gives trainees to see the patient and discuss the case with the supervising physician. We are committed to giving our residents ample time," says Dr Capobianco. Dr Boes adds that some of the best learning occurs at the bedside without technological aids. "Neurologists are hands-on. We



Robert D. Brown, Jr, MD



David W. Dodick, MD

carry those black bags for a reason. We teach residents to use the patient's clinical history and physical examination findings to identify where in the nervous system the problem is located and what it might be and to use test results to help determine if their original hypotheses were correct."

Across the 3 sites, close clinical supervision continues to foster the "reciprocal learning" between supervisor and trainee that characterized the early days of Mayo's neurology program.

Networking Within Mayo Clinic and Beyond

While the core clinical training and all subspecialty training are available at each site, residents may choose to rotate among Mayo sites for particular training or research experience. This option gives residents opportunities to see a new patient population, to connect with fellow residents, and to be mentored by faculty in another location. All neurology physicians make sure residents are aware of opportunities to participate on committees within the department, the larger institution, and national professional organizations. For example, elected by their peers, the past 3 chairs of the American Academy of Neurology's Consortium of Neurology Residents and Fellows have been Mayo trainees. Such experiences give Mayo residents a connection to the larger community.

Becoming the Benchmark Program

The overriding goal of the 3 neurology residency program directors is to make Mayo Clinic the benchmark program against which other programs are measured. Mayo's residents and fellows come from all over the world, bringing with them unique and diverse experiences. "We take a lot of pride in them and want them to succeed," says Dr Boes, adding, "We have a wall here at Mayo with the names of all the neurology residents and

fellows who have trained here—more than 500 people—a long heritage. I know we're going in the right direction because we are often approached by physicians asking if we have a graduate willing to come to their practice, university, or country."

Almost a century after Dr John Doyle began his neurology residency at Mayo Clinic, a recent resident and now a member of the neurology staff in Jacksonville, W. David Freeman, MD, reflected on his own experience. "I knew I would get the best training here. I looked at 30 residency programs. I admire Mayo Clinic and all that it stands for—its philosophy of patient care; the 3 intertwined shields representing patient care, research, and education; ample time to spend with each patient; the fact that Mayo provides superior medical care. Second to these would have to be its facilities and educational support, such as the library, research resources, and assistance with publications. There is so much opportunity here for learning, conducting research, and publishing."

Mayo's neurology residency program honors its roots and strives to keep the training innovative and contemporary. As Dr Brown states, "That, combined with a faculty that views education not as a burden or task, but as a privilege and opportunity to work with a superb group of young colleagues—the future of our field—is at the heart of the Mayo Clinic neurology residency program across the 3 sites."

For more information and a complete program listing of Mayo Clinic's neurosciences residency programs visit

www.mayo.edu/msgme/neurosurg-programs.html
or www.mayo.edu/msgme/neurology-programs.html

Continuing Medical Education Opportunities

Parkinson's Disease & Movement Disorders, September 11-13, 2008, Hot Springs, Virginia. Clinical course for practitioners outlining current diagnostic and therapeutic options for care of patients with movement disorders. **Contact:** 800-462-9633.

Practical Clinical Neurology Review, October 29-November 1, 2008, Orlando, Florida. This course is designed for internal medicine physicians, family practice physicians, nurse practitioners, and registered nurses who encounter common neurologic problems in their clinical practice. The program format will consist predominantly of case-based presentations

of a comprehensive group of neurologic disorders and clinical neurologic topics. Each presentation will focus on the clinical evaluation and treatment of clinical vignettes of common neurologic problems. Discussions will be interactive and videotapes of real and "mock" patients will be used during the case presentations. Small-group didactic workshops will also be presented each day to review current, evidence-based updates in the diagnosis and treatment of different categories of neurologic diseases. **Contact:** 800-462-9633.

For a complete listing of neurosciences CME programs from Mayo Clinic visit
www.mayo.edu/cme/neurology-neurologic-surgery.html

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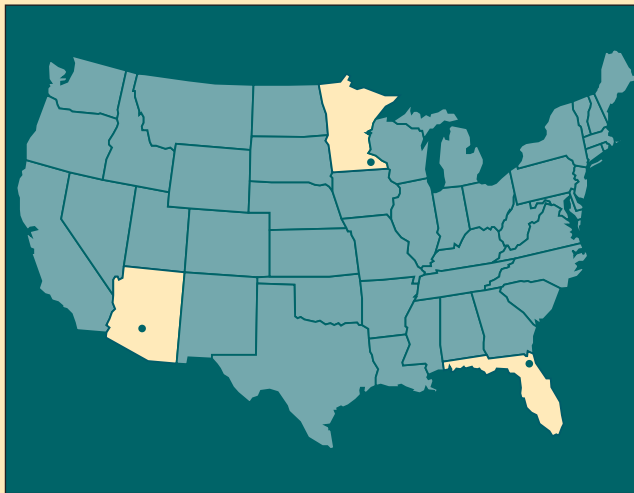


Expedited Patient Referrals to Mayo Clinic Departments of Neurology and Neurologic Surgery

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

Mayo Clinic Departments of Neurosurgery and Neurology



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Scottsdale, AZ 85259
480-301-6539 (within Maricopa County)
866-629-6362 (nationwide)

Minnesota

200 First Street SW, Rochester, MN 55905
Neurosurgical Consultation 507-284-8008
Neurologic Consultation 507-284-1588
All Other Consultations 800-533-1564

Florida

4500 San Pablo Road, Jacksonville, FL 32224
904-953-2103



4500 San Pablo Road
Jacksonville, FL 32224

200 First Street SW
Rochester, MN 55905

13400 East Shea Boulevard
Scottsdale, AZ 85259

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