

10 Most Commonly Asked Questions About Training in Interventional Neurology

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1 What is interventional neurology?

Historically, neurologists have been often perceived as expert diagnosticians who referred patients for interventional or neuroendovascular procedures. However, advances in therapeutics for neurologic diseases and trends toward minimally invasive treatments have led to the emergence and growth of neurologists who perform therapeutic procedures themselves. This has formed the basis of interventional neurology as a subspecialty.

Interventional Neurology began as a section of the American Academy of Neurology (AAN) in 1996. The section was initiated by neurologists who performed interventional pain management, but subsequently evolved to include members who perform neuroendovascular procedures. The purpose of the interventional neurology section as stated by the by-laws is to promote research, education, and credentialing for interventional procedures performed by neurologists, and to promote the access and availability of interventional procedures to the neurologic community.¹ Interventional procedures include, but are not limited to, invasive catheterization, injection for therapeutic purposes, or other invasive procedures used for diagnosis. Examples may include interventional pain procedures, spine interventions, muscle biopsies, diagnostic cerebral angiography, and endovascular interventions of the central nervous system, head, neck, and spine. Over the years, the perception of interventional neurology has become similar to that of interventional cardiology, representing a subspecialty focusing on (neuroendovascular) procedures performed through intravascular catheters.

Interventional Neurology was incorporated as an official term when the Society of Vascular and Interventional Neurology (SVIN) was started in August 2006 by neurologists who predominantly had interests in neuroendovascular procedures for the central

nervous system, head, neck, and spine. The purposes of this society are to represent a group of persons interested in the innovative treatment of cerebrovascular and other neurologic disorders, to foster cooperation among specialists and subspecialists who are involved in the interventional treatment of neurologic disorders, to foster scientific research in the field of cerebrovascular and interventional neurology through internal collaboration and collaboration with other groups, to raise awareness and disseminate knowledge concerning developments in vascular and interventional neurology, to promote and improve the training of vascular and interventional neurology in teaching programs in collaboration with other organizations, and to address practice issues faced by specialists who are involved in the interventional treatment of neurologic disorders.²

2 What is the history behind neurologists performing neuroendovascular procedures?

The first cerebral angiogram was performed by a neurologist originally from Portugal named Egaz Moniz in 1927. Interestingly, Moniz did receive the Nobel prize in 1949, not for his work on cerebral angiography but rather for his work on frontal leucotomy.³ Initially, some neurologists performed cerebral angiograms by direct carotid puncture to diagnose tumors and mass effect, and pneumoencephalograms for similar indications. Radiology started dominating the practice of performing diagnostic cerebral angiography since the advent of transfemoral catheterization approaches in the 1970s. Both radiologists and neurosurgeons started performing neuroendovascular procedures in the early 1990s. However, early case reports of intra-arterial thrombolysis in the 1980s rekindled an interest in this field for neurologists. Neurologists performing interventional procedures was first advocated by Kori in an article published in 1993 entitled, "Interventional neurology: a specialty whose time has come."⁴ Although pioneer neurologists like Camilo R. Gomez performed neuroendovascular procedures, formal participation of neurologists started with 2 neurologists, Adnan I Qureshi and Edgard Periera, entering into neuroendovascular fellowships in 1998.

Before this, neurologists who wanted to enter interventional neuroradiology required a second residency in radiology. The Accreditation Council for Graduate Medical Education (ACGME) formalized the eligibility of neurologists to train in endovascular surgical neuroradiology (ESN) in 2003. As of January 2008, there are about 50 neurologists in the United States who have completed formal training in this field.

3 What are the similarities and differences between the 3 subspecialties of interventional neuroradiology, ESN, and interventional neurology?

Physicians trained in these subspecialties undergo similar fellowship training programs in minimally invasive neuroendovascular procedures. The basic principle of all endovascular procedures (regardless of specialty) involves percutaneous entry into the femoral, radial, or brachial artery. Guide catheters or sheaths are introduced through the aorta into the supra-aortic vessel of interest. Microcatheters, balloon catheters, and stent delivery devices are introduced through the guide catheter and guided to the target lesion with flexible microwires. Advanced designs of microcatheters including flow-directed microcatheters have allowed highly selective delivery of coils, embolic materials, and drugs into regions of interest.⁴

However, the main differences lie in the residency training that qualify candidates for the advanced training. Interventional neuroradiologists undergo residency training in radiology, endovascular neurosurgeons undergo residency training in neurosurgery, and interventional neurologists undergo residency training in neurology. In an attempt to create a single name for physicians trained within this field, the ACGME decided to call this subspecialty ESN in 2000. The American Society of Interventional and Therapeutic Neuroradiology has also since changed its name to the Society of NeuroInterventional Surgery (SNIS), which better reflects the multiple specialties who are now training in this field and becoming members of this society. A summary of the different medical organizations involved in ESN and interventional neurology training is listed in Table 1.

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TABLE 1. Various Organizations Involved in Performing Some Aspect of Endovascular Surgical Neuroradiology and Interventional Neurology

Organization	Primary Membership	Website
American Academy of Neurology* (AAN)	Neurologists	http://www.aan.com/
American Association of Neurological Surgeons* (AANS)	Neurosurgeons	http://www.aans.org/
American Society of Interventional Pain Physicians (ASIPP)	Interventional Pain Practitioners	http://www.asipp.org/
American Society of Interventional and Therapeutic Neuroradiology*† (ASITN)	Neurointerventional Practitioners	http://www.snisonline.org/guest/guest.php
American Society of Neuroradiology* (ASNR)	Radiologists	http://www.asnr.org/
Congress of Neurological Surgeons* (CNS)	Neurosurgeons	http://www.neurosurgeon.org/
Society for Cardiovascular Angiography and Interventions (SCAI)	Cardiologists	http://www.scai.org/
Society of Interventional Radiology* (SIR)	Radiologists	http://www.sirweb.org/
Society of NeuroInterventional Surgery* (SNIS)	Neurointerventional Practitioners	http://www.snisonline.org/guest/guest.php
Society of Vascular and Interventional Neurology (SVIN)	Neurologists (Interventional Neurologists and Vascular Neurologists)	http://www.svineuro.org/
Society for Vascular Surgery (SVS)	Vascular Surgeons	http://www.vascularweb.org/

Procedures are listed in alphabetical order.

*Current members of the Neurovascular Coalition Writing Group.

†The ASITN has changed its name to the SNIS.

4 How does training in interventional neurology differ from similar training through other specialties?

The final pathway for training is a fellowship in ESN for applicants from neurology similar to applicants from neurosurgery and radiology. One year of graduate medical education in using catheter technology, radiologic imaging, and clinical expertise to diagnose and treat diseases of the central nervous system is provided. However, the pathway to the one year training in ESN differs depending upon the previous background of the applicant. For neurologists, the ACGME requires training in an accredited neurology residency (4 years, including the PGY-1 year), a vascular neurology fellowship or equivalent (1 year), preparatory neuroradiology training (1 year), and fellowship training in ESN (2 years). Similar training in radiology requires a radiology residency (5 years), diagnostic neuroradiology fellowship (1 year), and fellowship in ESN (1–2 years). Similar training in neurosurgery requires a neurosurgery residency (6–7 years), preparatory neuroradiology training (1 year), and fellowship in ESN (1 year). Some of the training requirements can be completed during the residency training.

5 What are the ACGME training requirements to be eligible for an ESN fellowship?

The ACGME approved the Guidelines for Training in ESN in June 2000.⁵ The program requirements for training from a neurology background were approved by the ACGME in May 2003. According to these ACGME guidelines, residents entering from a neuro-

logy background must have fulfilled the following preparatory requirements:

1. Completed an ACGME-accredited residency in neurology.
2. Completed an ACGME-accredited 1-year vascular neurology program.
3. Completed a 3-month course in basic radiology skills acceptable to the program director where the neuroradiology training will occur. The basic radiology skills and neuroradiology training may be acquired during elective time in the neurology residency.
4. Completed 3 months of clinical experience in an ACGME-accredited neurologic surgery program, which may be acquired during elective time in neurology and/or vascular neurology training.
5. Completed at least 12 months of training, preferably consecutive, in neuroradiology. Candidates who do not come from a radiology training program shall have access to a 1-year period of training in neuroradiology in the institution sponsoring the ESN program. The purpose of this preparatory year is to gain experience in performance and interpretation of diagnostic cerebral angiography.⁵

The basic radiology skills and neuro-radiology training are meant to familiarize the trainee with percutaneous arterial access, pharmacology of contrast agents, principles of radiation physics and safety, and conceptual understanding of indications, techniques, and limitations of various radiologic diagnostic modalities. The 3 months of clinical experience in neurosurgery is meant to familiarize the trainee with the indications for various neurosurgical procedures, a con-

ceptual understanding of techniques of various neurosurgical procedures, and basic principles of periprocedure management of these patients. Trainees are not expected to learn how to perform neurosurgical procedures. The 12 months of training in neuroradiology learning to perform and interpret diagnostic cerebral angiograms is generally incorporated as part of the first year of the NeuroInterventional fellowship.

6 What are the requirements for an ESN training program?

There are 24 ESN training programs listed on the SNIS website⁶ and an additional 8 programs listed on the SVIN website.⁷ Unfortunately, because the publication of the ACGME guidelines (see question 3), only 4 programs have received ACGME accreditation as of January 2008. Institutional program requirements can be found at the ACGME Neurologic Surgery Program requirements website last updated on January 2008.⁵ Program directors require board certification by the American Board of Radiology, American Board of Neurologic Surgery, the American Board of Psychiatry and Neurology, or possess qualifications acceptable to the residency review committee.

The ACGME document states “An adequate variety and number of ESN procedures must be available for each resident. Each program must perform at least hundred therapeutic ESN procedures per year. These procedures include the treatment of aneurysms, brain arteriovenous malformations, arteriovenous fistulas of the brain, tumors of the central nervous system, occlusive vascular diseases, revascularization, traumatic in-

TABLE 2. Suggested Qualification Requirements for Performing Neuroendovascular Procedures for Interventional Neurologists^{1,2}

Procedures	Experience
Diagnostic cervicocerebral angiography	Minimum of 100 cases under supervision Minimum of 50 cases annually
Carotid artery stent placement	Minimum of 25 cases under supervision
Intra-arterial and mechanical thrombolysis	Minimum of 10 cases under supervision
Intracranial aneurysms	Minimum of 30 cases under supervision
Intracranial stent placement	50 Procedures requiring intracranial microcatheter placement 25 Cases for intracranial stenosis under supervision
Brain arteriovenous malformations	50 Procedures requiring intracranial microcatheter placement Minimum of 15 cases for brain AVMs under supervision
Other neurointerventional procedures (e.g. provocative and occlusion test, spinal endovascular procedures, and extracranial endovascular procedures)	Meeting criteria for diagnostic angiography and intracranial procedures should be sufficient

jury, maxillofacial vascular malformation, and tumors. In addition, the program must provide adequate training and experience in invasive functional testing.” The documents further states “To ensure adequate teaching supervision and evaluation of a resident’s academic progress, the faculty-to-resident ratio must be at least one full-time faculty person for every resident enrolled in the program.”⁵

7 What are the hospital credentialing requirements to perform neuroendovascular procedures?

The credentialing requirements to perform procedures are determined by individual hospitals. The American Medical Association provides broad recommendations about hospital privileges and accreditations for procedures stating that, “Decisions regarding hospital privileges should be based upon training, experience, and demonstrated competence of candidates.”⁸ Hospitals are moving toward procedure-specific credentialing as competency in one neurointerventional procedure may not necessarily imply competency in others. One such example is carotid artery stent placement (CAS), which is being performed by physicians with variable levels of experience and training. Different societies have published variable training guidelines for performing CAS, ranging from 4 CAS procedures and 25 noncarotid stent procedures plus attendance at a “hands-on” course (16 hours AMA category 1 CME)⁹ to a minimum of 25 CAS procedures with at least half as primary operator.¹⁰

The Neurovascular Coalition Writing Group [AAN, American Association of Neurologic Surgeons, Congress of Neurologic Surgeons (CNS), American Society of Interventional and Therapeutic Neuroradiology, the American Society of Neuroradiology, and the Society of Interventional Radiology] recom-

mend that a physician accumulates a total of 100 diagnostic cervicocerebral angiograms before postgraduate training in cervicocerebral interventional procedures, including CAS.¹¹ However, this document did not provide guidelines on specific procedures. The SVIN and American Society of Neuroimaging have published a guideline for training in specific procedures.¹² A summary of these procedure-specific guidelines can be found in Table 2. Hospitals generally require documentation of the number of procedures performed and complication rates for credentialing.

8 Will I be able to find a job after this training?

The need for interventional neurologists is growing. There has been a dramatic increase in neuroendovascular procedures in the last decade largely driven by improvements in device technology.¹³ The Advisory Board Company, a health care market research firm, and Goldman Sachs Investment Research estimate that there are 2.4 million patients in the United States who can benefit from neuroendovascular procedures and predict increases in the market shares for neuroendovascular devices.¹⁴ The Brain Attack Coalition identified a neurointerventional specialist as a necessary component of a comprehensive stroke center. Surgical and endovascular techniques, including clipping and coiling of intracranial aneurysms, carotid endarterectomy, and intra-arterial thrombolytic therapy was one of the key areas identified for comprehensive stroke center designation. The statement further stated that much of what distinguishes a comprehensive from other facilities is expertise and infrastructure in 3 key areas: diagnostic radiology, endovascular therapy, and surgery because these areas were considered vital in the management of patients with complex ischemic and hemorrhagic strokes. The coalition also recommended that the neurointerventional specialists

accrue significant experience because studies have shown that increasing experience reduces complication rates.¹⁵ All of these factors suggest there will be a need for highly trained neurointerventional specialists for future stroke centers.

9 I am interested in interventional pain management and want to train in neurology. How do I pursue a training and career in interventional pain management?

Interventional pain management in most institutions is administered by the anesthesiology department. However, more physicians training from other specialties such as physical medicine and rehabilitation, neurology, and psychiatry are participating in these fellowships. Fellowship training consists of 1 year of didactic training. The American Society of Interventional Pain Physicians (ASIPP), which was formed in 1998, is the main voice for physicians interested in interventional pain management and offers a subspecialty board certification for the field.¹⁶ Neurologists have been training in interventional pain fellowships since the 1990s. Some neuroendovascular fellowships will include training in spine interventions, such as vertebroplasty and discography.

10 I am interested in interventional neurology. How do I get more information?

There are several websites, medical organizations, and meetings that offer information on interventional neurology. The interventional neurology section of the AAN has a yearly meeting at the annual AAN meeting that can be attended. The SVIN has a website with information and listings of some fellowship opportunities.¹⁷ The SNIS also has web-

site with similar information.¹⁸ These organizations encourage interested persons to apply for membership. For candidates interested in ESN and who want to train in neurosurgery, the American Association of Neurologic Surgeons (AANS) and Congress of Neurologic Surgeons (CNS) have yearly meetings.¹⁹

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